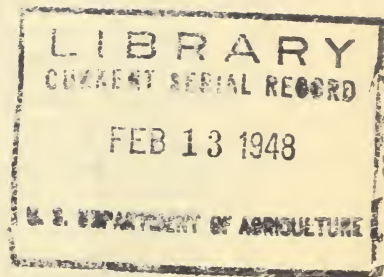# Historic, archived document

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Progress

of

Farm

Mechanization

By Martin R. Cooper,
Glen T. Barton, and Albert P. Brodell

FARM MECHANIZATION has made striking progress, and this progress, more than any other single thing, enabled American farmers to produce the large volume of agricultural products that helped so much to win World War II.

Some of the future potentialities of mechanization cannot be fully measured at this time. Others seem almost assured for the next farming generation.

This publication keynotes the place of farm mechanization in the greatest of all farm production jobs, and analyzes the influences of mechanization on farm employment, on efficiencies in production, and on production costs and returns of agriculture.

In all farm production, each farm worker in wartime in 1945 produced enough agricultural products to support himself and more than 13 others, whereas in 1920 one farm worker had supported himself and 9 other persons and in 1820, himself and only a little more than 3 other persons.

Each man-hour of farm labor meant 44 percent more gross production in 1945 than it did in 1917-21. Half of these savings in hours per unit of product resulted from mechanization. Other technological developments, primarily increases in yields of crops and livestock, were responsible for the other half.

Change in pattern of mechanization has been outstanding. Farm horses and mules have been rapidly replaced by tractors, trucks, and automobiles during the last third of a century. Combines, tractor-plows, tractor-cultivators, mechanical corn pickers, milking machines and other modern farming equipment are continuing to replace horse-drawn equipment and hand work. A modern tractor and its associated equipment now saves 850 hours of man labor compared with the time required with the animal power and equipment used a generation ago.

Thirty percent of the increase in food supplies for feeding an increasing population from 1920 to 1942 came from acreages released by the decline in horses and mules; 70 percent came from increased crop and livestock yields and from decreased exports. Crop production per acre has increased about one-fourth, and livestock production per unit of breeding stock has increased about one-third during the last quarter century. But crop acreages in 1944 were about the same as the 1917-21 average.

Mechanization has made possible more timely operations and this has contributed to increased farm production, especially in years when adverse weather delayed the preparation of land and planting.

The Corn Belt and the Great Plains are highly mechanized. Farms are generally less mechanized in the South than elsewhere. The next generation of farm people can expect some striking developments. Farm electrification and the use of new equipment proceeds at a rapid pace, and will aid farmers and farm women everywhere in doing things better and more easily.

Total physical production costs (labor, power, and other resources) per unit of farm output have decreased about 26 percent during the last quarter century and physical costs of labor, power, and machinery per unit of output about 30 percent. These large reductions in physical costs have benefited many individual farmers and agriculture as a whole.

The ratio of prices received by farmers to prices paid by farmers has fluctuated so violently that price changes have overshadowed increases in physical efficiency. During a large part of the period 1910–45 farm operators and family workers received, on an average, less net return per hour of labor than hired farm workers but many operators received additional agricultural income in the form of rent and interest on owned land and property.

Thus far, the march of farm technology has not always meant the release of farm workers. Labor-intensive enterprises and more production per acre and per animal have absorbed many of the people. This increased production is a principal cause of the increased physical efficiency in agriculture as a whole. Outlets for a large volume of farm products will be needed if farmers are to receive appropriate benefits from further increases in efficiency.

Progress of Farm Mechanization

By Martin R. Cooper, Glen T. Barton, and Albert P. Brodell,
Agricultural Economists [1]

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Peacetime prosperity and war activity always stimulate the demand for farm mechanization. The Civil War and the later settlement of the West accelerated the manufacture and improvement of labor-saving farm machines for preparing land, seeding, cultivating, and harvesting. By 1880, many farm machines—including hay presses and loaders and threshing machines—had important features of our modern machines, although refinements in design and construction were to follow. In World War I, with its race for food, and the large agricultural production that came in the 1920's sharp increases occurred on the farms in the number of the much-heralded tractors, motortrucks, and grain

combines and the popular hay loaders, manure spreaders, and labor-saving tillage, planting, and harvesting machines and tools. In World War II the urgent demand for farm machinery was only partially filled. But scarce as wartime farm machines were in relation to wartime needs, so many labor-saving machines were manufactured and sold that farmers now have more labor-saving machinery than at any other time in history.

Farm tractors that are as versatile as horses and mules in doing field and road jobs appeared on many more farms during the war, and some large productive farms added a second or third tractor. The number of grain combines, pick-up balers, side-delivery rakes, corn pickers, field forage harvesters, and milking machines actually increased in wartime, too. Now, new and better machines and tools are on the way to replace some of the finest machines and tools found anywhere in the world.

More work in less time and with less human effort—and on small farms as well as on large farms—is the central theme of modern farm mechanization. Less waste and better quality of product through better and more timely handling are motivating influences in the creation of better farm machines.

ACHIEVEMENTS OF MECHANIZATION

It has been said that the corn crop of 1840 was planted with the hoe, the plow, and the ax. This was probably literally true of those places where the land was being cleared of trees, or where the land was infested with stumps and roots. The hand-turned grindstone in the back yard that kept the farm tools sharp was a valued labor-saving item of farm mechanization.

As the cleared lands became free of obstacles, as the prairie sods were broken, and as improved machines came into use under rather favorable conditions, there was a gradual lessening of the hours of man labor required to produce a bushel of wheat or corn or a bale of cotton. Around 1880, our farmers produced a bushel of corn and a bale of cotton with little more than half the labor that had been used in 1800 and the time devoted to a bushel of wheat was cut to 40 percent. By 1940, about 190 hours were required to produce a bale of cotton, compared with the 300 hours some 60 years earlier. Even more progress had been made in regard to wheat and corn. Only 47 hours of direct man work were required to produce 100 bushels of wheat, compared with 152 hours in 1880; 83 hours were required to produce 100 bushels of corn, compared with 180 hours (table 1).

All of the decrease in the hours of work used in growing and harvesting a bushel of grain or a bale of cotton is not directly attributable to new or improved machines. Yields per acre have increased and this increase has called for proportionately less labor per bushel or pound. This is true especially of the crops that are harvested with machines. Expanded production in areas of low labor requirements has reduced the national average requirements per acre and per unit of production. Changes in cropping practices, even where the work is still done by hand, have frequently reduced the hours per unit of product. For example, a much larger part of the corn crop is harvested from the stand-

TABLE 1.—*Estimated man-hours used to produce an acre of wheat, corn, and cotton, and 100 bushels of wheat and corn, and a 500-pound gross weight bale of cotton for designated periods, United States average*

Crop and item	Yearly average for—					
	About 1800	About 1840	About 1880	About 1900	About 1920	About 1940
Wheat:						
Man-hours per acre before harvest..................	16	12	8	7	5.5	3.7
Harvest...................	40	23	12	8	6.5	3.8
Total....................	56	35	20	15	12.0	7.5
Yield per acre [1]........bushels	15	15	13.2	13.9	13.8	15.9
Man-hours per 100 bushels.......	373	233	152	108	87	47
Corn for grain:						
Man-hours per acre before harvest..................	56	44	28	22	19	15
Harvest...................	30	25	18	16	13	10
Total....................	86	69	46	38	32	25
Yield per acre [1]........bushels	25	25	25.6	25.9	28.4	30.3
Man-hours per 100 bushels.......	344	276	180	147	113	83
Cotton:						
Man-hours per acre before harvest..................	135	90	67	62	55	46
Harvest...................	50	45	52	50	35	52
Total....................	185	135	119	112	90	98
Yield of gross lint per acre [1] ....pounds	154	154	196	198	160	257
Man-hours per bale............	601	439	304	283	281	191

[1] Yields for 1800 and 1840 are estimates by the authors. Yields for the other years are 5-year averages of published data, centered on year shown.

ing stalk by hand than in earlier days; formerly nearly all corn was cut, shocked, and then husked, and all by hand. In the first instance it takes only 6 or 7 hours to harvest an acre compared with 18 to 20 hours when the older methods were followed.

Fewer Farm Workers Needed

Ours was decidedly an agricultural nation for a long time after the colonial period. It has been estimated that nearly 72 percent of the working force of the United States in 1820 was engaged in agricultural pursuits, and only about 28 percent pursued nonagricultural livelihoods (table 2). As time passed the agricultural force represented a smaller and smaller proportion of the total labor force. By 1920, or shortly after the close of World War I, it was only 27 percent of the total force. Twenty years later, this percentage had dropped to 18. It is undoubtedly true, although we have no definite measure, that an even smaller percentage is now engaged in agriculture. In relation to the total population during

the 120-year period from 1820 to 1940 the farm labor force found its numbers decreasing from about 22 percent to about 7 percent (table 2).

TABLE 2.—*Relation of labor force in agriculture to total labor force and total population of the United States, census years 1820–1940*

[Labor force includes persons 10 years old and over]

Year	Labor force [1]			Total population [2]	
	All occupations	Agricultural pursuits	Percentage farm labor force is of total	Total	Percentage farm labor 'force is of total population
	Number	*Number*	*Percent*	*Number*	*Percent*
1820..........	2,881,000	2,068,958	71.8	9,638,453	21.5
1830..........	3,931,537	2,772,453	70.5	12,866,020	21.5
1840..........	5,420,000	3,719,951	68.6	17,069,453	21.8
1850..........	7,697,196	4,901,882	63.7	23,191,876	21.1
1860..........	10,532,750	6,207,634	58.9	31,443,321	19.7
1870..........	12,924,951	6,849,772	53.0	38,558,371	17.8
1880..........	17,392,099	8,584,810	49.4	50,155,783	17.1
1890..........	23,318,183	9,938,373	42.6	62,947,714	15.8
1900..........	29,073,233	10,911,998	37.5	75,994,575	14.4
1910..........	37,370,794	11,591,767	31.0	91,972,226	12.6
1920..........	42,433,533	11,448,770	27.0	105,710,620	10.8
1930..........	48,829,920	10,471,998	21.4	122,775,046	8.5
1940..........	52,148,251	9,162,547	17.6	131,669,275	7.0

[1] Sixteenth Census of the United States: 1940 Series P–9, No. 11.
[2] Reports of the Bureau of the Census. Population data for 1820–1940 are from table 3, 1940 Census, Population, vol. II, part 1. During this period the month in which the census was taken varied, hence the month for which the population was reported varied.

It has been estimated that in 1820 each person on the farms in the United States produced enough food and fiber to support himself (or herself) and a little more than one-fourth of enough for an additional person (table 3). By the end of World War I, or by 1920, one farm person was producing enough to support himself, and two other persons, and nearly half enough for a fourth person. During the 20 years between the wars, 1920–40, production per farm person was again increased enough to support an additional one-half person, making about three extra persons. Then came a climactic increase during World War II. Each farm person produced enough to support, here and abroad, more than 5 and a half persons in 1945. In 5 years there was an increase per person of nearly 45 percent.

Persons supported can be measured in terms of people employed on farms as well as in terms of people living on farms. Measured in this way the increase per farm worker has been somewhat less than the increase in total persons supported per farm person but there have been variations from time to time (table 3). Until about 1910 a large percentage of the young people remained on the farms and immigrants of working age increased the farm-employment rolls. From 1910 to 1930 farm population and employment decreased at about the same rate. Depression increased this population. World War II broke out in Eu-

rope, and men and women, boys and girls began to leave the American farms by hundreds and flock to defense work. Then war broke on the United States and the hundreds became thousands. In all, 5 million people left the farms. But so large had been the farm population that total farm employment decreased by only 800,000 workers.

TABLE 3.—*Total farm population and farm employment, and average number of persons supported per farm person and per farm worker, United States, 1820–1945*

Year	Total farm population Jan. 1 [1]	Total farm employment [2]	Persons supported by one farm person [3]		Total persons supported at home and abroad by one farm worker [4]
			Supported persons of the United States	All persons supported at home and abroad	
	Millions	*Millions*	*Number*	*Number*	*Number*
1820.........	7.7	2.2	1.20	1.28	4.52
1830.........	9.8	2.9	1.27	1.35	4.51
1840.........	12.3	3.9	1.33	1.41	4.49
1850.........	15.8	5.1	1.44	1.51	4.68
1860.........	20.1	6.6	1.47	1.65	5.07
1870.........	22.4	7.2	1.60	1.78	5.60
1880.........	27.1	9.0	1.66	2.08	6.42
1890.........	29.4	10.4	1.84	2.26	6.59
1900.........	31.2	11.4	2.15	2.86	8.05
1910.........	32.1	12.1	2.54	2.97	7.99
1920.........	31.6	11.4	2.87	3.47	9.94
1930.........	30.2	11.2	3.61	4.01	10.96
1940.........	30.3	10.6	3.74	3.93	11.31
1945.........	25.2	9.8	5.08	5.64	14.54

[1] Data for 1910–45 taken from Bureau of Agricultural Economics report, Farm Population Estimates United States and Major Geographic Divisions, 1910–46, rounded to nearest 100 thousand. (Processed) June 1946. Data for 1820–1900 are estimates by the authors based largely on total population and numbers of persons engaged in agricultural pursuits.

[2] Data for 1910–45 taken from releases on farm employment issued by Bureau of Agricultural Economics, rounded to nearest 100 thousand. Data for 1820–1900 are estimates by the authors, based largely on the size of the labor force engaged in agricultural pursuits, table 2.

[3] Level of support at any given date is total food and fiber available for domestic consumption from farm production and from imports. The number of persons supported at home and abroad at the above level of support divided by the total farm population represents the total number of persons supported by one farm person.

[4] Total persons supported divided by total number of persons in farm employment in United States.

"Support" of these people by farmers has not meant the same thing throughout the 125 years for it is well known that in the early part of this period farm people did many things that were later done by city people. This was true of work in the farmhouse and on the farm.

But it is conceivable that the support furnished to consumers today may be greater than in early years when diets and clothing were simple if not meager. The changing composition of the diet has increased the volume of support supplied to consumers by farm people. Consumption of farm products per person increased, especially during World War II and immediately thereafter.

Perhaps achievements can best be measured by scanning further the century of mechanization that has now passed into history.

According to one enthusiastic writer, by 1840 improved plows, harrows, and other implements, and the introduction of rollers, cultivators, and drill-barrows and many additional items had made possible the working of a farm with half the labor that had been generally used 40 years before. But somewhat later, another writer said that an Ohio farmer of 1860 who used the best methods of production then available could probably produce his crops with two-thirds the labor required in 1840.

The year 1840 marks the beginning of worth-while results by inventors and experimenters who had been making persistent trials and studies throughout 50 years. The sickle of colonial days had virtually given way to modified types of the scythe and the grain cradle. In 1837 farmers were enthusiastic about the better cradles that were used in parts of the East, and the American scythe of that period, with its longer and thinner blade, was much used for several years after mowing machines were in the fields. Crude as the machines and tools of that time were compared with current models, they represented a long step forward from the beginning of the century.

Many makes of farm machines were tried out before 1850. Farm machines of the local blacksmith shop were being replaced by factory-made machines with wide commercial distribution. McCormick's reaper was becoming a reality. Portable horse-drawn power units and threshing machines were seen. The fanning mill, through with its critical period of experimentation, was in general use for cleaning grain. Horse-drawn mowing machines were at work in the hay fields. Shovel cultivators were replacing many steel hoes, and the steel walking plow was a few years old.

Then came the Civil War, the succeeding expansion, the Great War, the interwar period, and World War II with their described stimulations to mechanization.

More Output Per Farm Worker

The volume of farm output [2] in the United States by 1870 amounted to approximately 2.5 billion dollars. During the next 70 years, or by 1940, the volume of agricultural output had increased about 2.7 times, and amounted to 9.3 billion dollars in terms of 1870 agricultural price levels. This increase in agricultural output was accomplished with an increase of only 48 percent in farm employment (table 4). This large increase in agricultural output with so relatively small an increase in number of farm workers means that each worker increased his output 152 percent during the 70 years.

Several of the things that contributed to this huge increase in output per worker have been mentioned. Increased farm mechanization un-

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[2] Farm output is gross farm production minus farm-produced power, and is approximately that part of total production which is available for human use. Farm-produced power is the cost in constant dollars of raising and maintaining farm horses and mules. For a full discussion of farm output, gross farm production, and farm-produced power, see Farm Production in War and Peace. By Glen T. Barton and Martin R. Cooper. Bur. of Agr. Econ. F. M. 53. (Processed).

TABLE 4—*Indexes of farm output, volume of farm power, machinery and equipment, farm employment, and farm population, United States, census years 1870–1940 and 1944–46*

[1870 = 100]

Year	Indexes of volume of farm output		Indexes of volume of farm power, machinery, and equipment		Farm output per unit of farm power, machinery and equipment [5]	Index of farm employ- ment [6]	Index of farm popula- tion [7]
	Total [1]	Per worker [2]	Total [3]	Per worker [4]			
1870........	100	100	100	100	100	100	100
1880........	156	125	163	130	96	125	121
1890........	183	125	232	159	79	146	131
1900........	240	151	295	186	81	159	139
1910........	261	154	385	228	68	169	143
1920........	313	197	477	300	66	159	141
1930........	324	208	471	302	69	156	135
1940........	373	252	434	293	86	148	135
1944........	446	319	494	353	90	140	114
1945........	440	321	517	377	85	137	112
1946........	453	324	542	387	84	140	116

[1] 1870–1910 based on "Ideal index," see table 61, p. 126 of U. S. Dept. Agr. Technical Bulletin 703, Gross Farm Income and Indices of Farm Production and Prices in the United States, 1869–1937. By Frederick Strauss and Louis H. Bean. 1940.
1920–44, based on index of "Farm Output" contained in Bureau of Agricultural Economics Farm Management Report 53. Glen T. Barton and Martin R. Cooper. op. cit.
[2] Index of total farm output divided by index of farm employment.
[3] Volume is in terms of 1935–39 average farm prices of all horses and mules (including harness) on farms 1870–1946, plus values of all farm machinery and equipment in terms of the 1935–39 wholesale price index, 1870–1910, and in terms of 1935–39 average farm prices 1911–46.
[4] Index of total volume of farm power, machinery, and equipment, divided by index of farm employment.
[5] Index of farm output divided by index of total volume of farm power, machinery, and equipment.
[6] See footnote 2, table 3.
[7] See footnote 1, table 3.

doubtedly contributed a lot directly to output per worker, and has made possible much of the Nation's rapid progress in expanding various lines of production that are well suited to mechanical production. An indication of mechanical possibilities in these directions is shown by the increasing volume of power and machinery on farms (table 4). In 1940, for example, the total volume of farm power (animal and mechanical), farm machinery, and farm equipment was 334 percent larger than the volume in 1870. As the number of workers engaged in agriculture increased during the 70 years by 48 percent, the volume of farm power, machinery, and equipment per worker increased less rapidly than the total increase, or about 193 percent.

In the war years, 1940–45, farm employment decreased 11 index points, and total farm power and machinery increased 83 index points. These changes resulted in an increase in volume of machinery and power per worker of 84 index points, or 30 percent. During the same period total agricultural output increased about 18 percent. During 1946, the first full year after the war, farm employment increased

about 2 percent; the total volume of power, machinery, and equipment continued to increase; and the volume of farm output was larger than in any year during or before the war.

TABLE 5.—*Farm employment, man-hour requirements, and gross farm production per worker, United States, selected periods and years, 1909 to 1945*

[For indexes, 1917–21 = 100]

Period or year	Average annual farm employment		Man-hour requirements		Man-hours per worker		Gross production per worker
	Number of workers [1]	Index	Number [2]	Index	Number	Index	Index
	Thousands		*Mil. hrs.*		*Hours*		
1909–13......	12,094	106	22,262	97	1,840	91	88
1917–21......	11,403	100	22,983	100	2,016	100	100
1927–31......	11,233	99	22,193	97	1,976	98	108
1939.........	10,740	94	20,454	89	1,904	94	118
1940.........	10,585	93	20,412	89	1,928	96	122
1941.........	10,361	91	20,617	90	1,990	99	129
1942.........	10,397	91	21,132	92	2,032	101	142
1943.........	10,263	90	21,026	91	2,049	102	140
1944.........	10,037	88	21,182	92	2,110	105	149
1945.........	9,844	86	20,655	90	2,098	104	152
Percentage change: 1917–21 to 1939	−6	....	−11	....	−6	....	18
1939 to 1944...	−6	....	3	....	12	....	26
1939 to 1945...	−9	....	1	....	11	....	29

[1] Farm employment as estimated by the Bureau of Agricultural Economics. Workers (farm operators, unpaid members of their families, and hired workers) doing 2 or more days of farm work during the week of inquiry each month are counted in farm employment.

[2] Estimated man-hour requirements are in terms of time required by average adult males to do various farm tasks. As many women and children do less work in an hour than an average adult male, actual hours of work required are in excess of those shown in this table. The estimates of man-hour requirements for the years before 1939 are based largely on data contained in the WPA National Research Project report, "Changing Technology and Employment in Agriculture," by John A. Hopkins. Since this report was prepared some slight revisions have been made in the estimates of total man-hour requirements for 1939–45, and revisions are being made of the requirements shown for periods previous to 1939. The unrevised series has been used throughout this publication.

Modern wars seriously disturb the farm labor force. Women and youths are called upon to do more of the work in the fields and barns, and older men to work longer hours—and faster—as the younger men are drawn into the armed forces and into factories. The great war that ended in 1945 was no exception. In each year of the conflict farmers and their families worked hard to overcome the scarcity of labor. More days of work and more hours a day, fuller use of domestic and imported seasonal workers, and the slighting and elimination of

some farm tasks, enabled fewer workers to produce more total food and fiber in each war year than we had ever produced in a year before. Good weather, good machines, good seeds, and other factors helped a lot, as will be shown later.

In 1945, each farm worker worked 11 percent more hours and turned out 29 percent more gross production than in 1939 (table 5). This average increase in gross production of 4.8 percent per year, with an average of 1.5 percent fewer workers, reflected a speeding up of trends that had been under way for many years. In the 20 years between the wars, 1917–21 to 1939, for example, gross production per worker increased 18 percent, or less than 1 percent per year compared with the 4.8 percent per year during World War II.

This achievement is all the more remarkable in view of the changing composition of the farm working force. The several million able-bodied men and experienced farm workers who left agriculture were not fully replaced in numbers even of less physically capable workers—older men, women, and children. The number of women farm workers almost doubled during wartime; thus, while total farm employment declined from 1939 to 1945 by about 9 percent, the average capacity of the farm labor force in terms of able-bodied men probably decreased considerably more.

From 1870 to 1920, the total volume of farm power and machinery combined increased more rapidly than the total volume of farm output [3]. In this 50-year period farm power, machinery, and equipment increased 177 percent more than farm output did, and in 1920 the index of farm output per unit of farm power, machinery, and equipment was only 66 compared with 100 in 1870 (table 4). From 1920 to 1946 the volume of agricultural output increased 45 percent but the volume of farm power, machinery, and equipment increased only about 14 percent. During most of the war and postwar years, 1940–46, the large increases in farm output were at least matched by increased volume of farm power, machinery, and equipment. This was achieved by large manufacture of tractors and other farm equipment in all years except 1943, and by the manufacture of a tremendous volume of repair parts for servicing old and new machines and equipment. In this way farmers managed to keep many tractors, automobiles, trucks, and other machines at work that ordinarily would have been junked.

Since 1910 there have been three important periods of farm mechanization. In that year mechanization had advanced to the point where farm employment began its long downward trend, even though total farm output continued its generally pronounced upward climb (fig. 1). The first period includes the years of World War I, and the first 10 or 12 years immediately following the war. The second period consists of the depression years of the 1930's, and the third period includes the years of the late 1930's and of World War II.

[3] It must be remembered that the measurement used here to show trend in volume of farm power, machinery, and equipment is in terms of constant prices, or in 1935–39 dollar values. This does not adequately measure the increase in horsepower with the coming in of tractors, trucks, and automobiles.
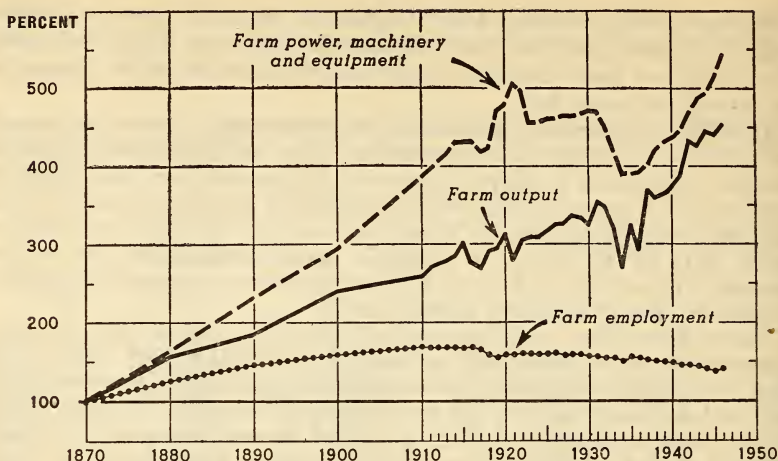
FIGURE 1—TOTAL VOLUME OF FARM POWER AND MACHINERY AND EQUIPMENT,
FARM OUTPUT, AND TOTAL FARM EMPLOYMENT, UNITED STATES, 1870-1946.
(VOLUME IN TERMS OF 1935-39 DOLLARS; INDEX NUMBERS, 1870=100)

Total volume of farm power—including horses and mules, machinery and equip-
ment—has increased more rapidly than total farm output. The first high point of
farm power, machinery, and equipment occurred in the early 1920's when farms were
being mechanized and horse and mule numbers were being reduced somewhat. The
recent wartime peak in volume resulted from large increases in numbers of tractors,
trucks, and labor-saving machines.

The steep upward rise in farm mechanization that was so evident
about 1910 was temporarily slowed down during World War I. But
during the early conversion years after that war the steep rise was re-
sumed. The peak was reached in 1921. This rise marked the beginning
of the long and continuous transition from animal power and animal-
drawn machines to tractor power and tractor equipment. The piling
up in volume of farm power, machinery, and equipment just after
World War I, therefore, was caused only in part by the continued
upward surge in farm output, in relation to farm employment. As the
transition progressed, and horses and mules and outmoded machines
were gradually displaced by modern power units and machines, we
needed less power, machinery, and equipment in terms of 1935-39
prices for a given volume of farm output.

With the industrial collapse of 1929 farmers reduced their machinery
purchases. In the depression that followed, money to buy gasoline and
expensive machines was very scarce; in places, horses and mules and
horse-drawn machines were again used extensively, displacing tractors
and power machines in the field. Restricted purchases of machines and
equipment in the depression years were accompanied by reduced pro-
duction. The severe droughts of 1934 and 1936 and some Government
programs temporarily held down production of certain products.

But beginning in about 1937 the upward climb in farm output was
resumed, and during World War II it was accelerated. Volume of power

and machinery on farms turned upward also, and the rate of increase exceeded the rate of increase in farm output.

By 1942 there was only a 33-point spread between the indexes of farm output and farm power, machinery, and equipment, each index representing 100 percent in 1870. In 1920–21 the average spread had been 195 index points (fig. 1). Since 1942 the relatively large increase in farm power, machinery, and equipment has widened the spread somewhat. The closing up of the distance between the two indexes was caused by the change from animal power and equipment to mechanical power and equipment, in which greater work capacity per dollar of value in power and equipment was obtained, and by the larger production for human use from a given acreage of land.

Development of the general-purpose tractor and its complement of tools in the 1920's, and the extensive use of rubber tires in the late 1930's helped greatly in advancing the effectiveness of machines.

PERCENT

INDEX NUMBERS (1935-39=100)

Gross farm production
per worker

Production per worker in
manufacturing and mining
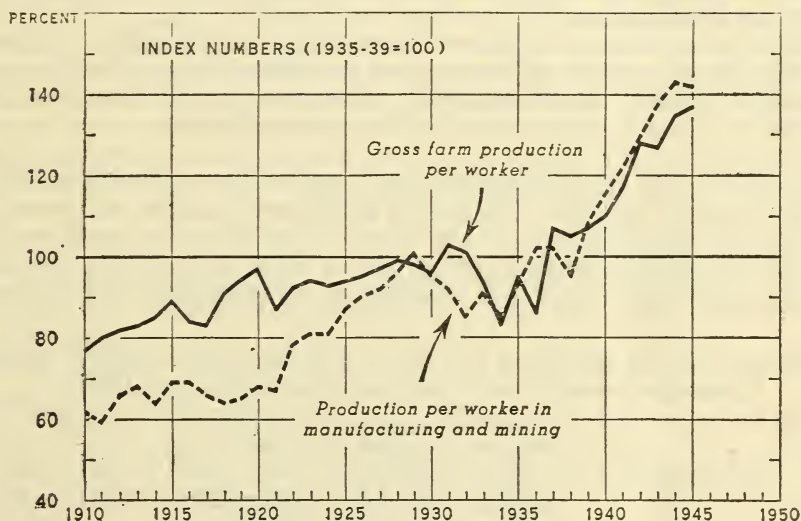
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FIGURE 2—PRODUCTION PER WORKER IN AGRICULTURE AND INDUSTRY,
UNITED STATES, 1910-45.

Over the long run, production per worker in manufacturing and mining has increased more than production per farm worker. But during the last 15 years increased production per worker in agriculture has been about the same as in manufacturing and mining.

This means that farmers were better supplied with labor-saving power units and machines in relation to production during World War II than is indicated by the indexes shown in figure 1. In the first place, a much larger percentage of the total volume of farm power and machinery was made up of modern labor-saving machines than was the case at any other time in our history. In the second place, increased production during this war was not the result of additional crop acres brought into cultivation, but came from increased crop yields and the

feeding of more livestock. During the last years of the 1930's, and generally during the war many more of the labor-saving machines such as modern tractors and tractor equipment, combines, corn pickers, pick-up hay balers, and milking machines were at work on the farms, whereas horse-drawn machines decreased. More is said later about changes in numbers of tractors and other farm machines.

Indexes of gross farm production per worker or farm output plus farm-produced power, and of production per worker in manufacturing and mining, are available for each year from 1910 through 1945 (fig. 2). From 1910 to 1920, gross production per worker in agriculture increased more rapidly than production per worker in manufacturing and mining. From 1920 to 1929, the opposite was true; but since 1929 increase in farm production per worker has about kept pace with production per worker in manufacturing and mining. Even in the war years when industry was geared to overtime production, the increase per worker over the 1935–39 average was little more than the increased production per farm worker.

Longer hours in the fields and barns, help by the families, and relatively large supplies of labor-saving machines did the job. Because of better weather than the average, because more fertilizer and better seeds were used, and because large inventories of feeds from current and previous years of production were fed, relatively large production was obtained from a given amount of human effort. The volume of modern production per worker varies greatly in different parts of the country. Generally, productive soils and labor-saving machines go hand in hand with high production per worker. In some areas, volume of livestock production contributes considerably to production per worker.

TABLE 6.—*Gross production per worker and amount of specified capital items per worker, by geographic divisions, 1944 and 1945* [1]

Geographic division	Gross production per worker, 1944 (U. S. average = 100)	Value of land, buildings, livestock, and equipment per worker, 1945 (U.S. average = 100) [2]	Land and buildings per worker, 1945 [3]	Livestock per worker, 1945 [3]	Equipment per worker, 1945 [3]	Total cropland per worker, 1944 [4]
	Percent	*Percent*	*Dollars*	*Dollars*	*Dollars*	*Acres*
West North Central......	168	170	7,668	1,592	926	88.1
Pacific.................	152	171	8,748	826	623	33.8
Mountain..............	143	151	6,470	1,820	719	66.5
East North Central......	131	154	7,175	1,184	863	43.3
Middle Atlantic.........	108	97	3,942	1,018	838	23.9
New England...........	96	88	3,960	745	529	15.6
West South Central......	71	73	3,433	616	320	33.4
South Atlantic..........	61	46	2,212	343	187	14.6
East South Central......	51	41	1,923	351	177	16.1
United States.....	100	100	4,622	844	513	37.4

[1] Based on number of farm workers from Bureau of Agricultural Economics Farm Labor Reports, 1944, the production year reported in the 1945 census.

[2] Livestock includes horses and mules and all other farm animals, including poultry and bees. Equipment includes motor vehicles, machinery, and equipment.

[3] From the 1945 Census of Agriculture.

[4] Land from which one or more crops were harvested plus estimated acreage of crop failure and summer fallow.

In the fertile grain and livestock region of the West North Central States, for example, production per worker in 1944 was 168 percent of the United States average, and the 1945 value of land and buildings, livestock, and equipment per worker was 170 percent of the average. In the East South Central States, on the other hand, production per worker was only 51 percent of the United States average, and the value per worker of the indicated capital items was 41 percent of the average (table 6). The West North Central farmers had about 88 acres of cropland per worker in 1944, whereas the East South Central farmers had about 16 acres per worker. Equipment per worker averaged $926 in value in the West North Central States compared with $177 in the East South Central division. Most of these relationships among the regions probably have not changed greatly since the 1945 census was taken.

Although total acres of cropland per worker in the South Atlantic and East South Central States is just about the same as the average for New England, production per worker in New England is nearly 60 percent greater than production per worker in the South Atlantic States, and almost double the production per worker in the East South Central States. The value of equipment per worker in New England is also about three times the value per worker in the 2 southern regions.

These differences are due in part to characteristics of the agricultural divisions that make them adaptable to different types of agriculture. These characteristics make the Southern Divisions well suited for such cash crops as cotton, tobacco, and vegetables. Because of low yields of feed crops and pasture per acre, however, they are not so well adapted to specialized livestock and poultry production. New England farmers, on the other hand, are much less dependent on their "cropland" acres for production. Large permanent pastures and hay lands furnish roughage for dairy cattle during summer and winter. Grain and other concentrates with which to round out the dairy enterprise are brought in, principally from the Corn Belt. Large poultry enterprises, from which the great eastern cities are supplied with fresh eggs and poultry meat, are fed by bringing in feed grown elsewhere. Thus, the resources per farm worker in buildings, machinery, and power, are much less dictated by the cropland acres per worker in New England than in the Southern Divisions.

Westward from New England are the Central and Northern areas of less rugged topography, more productive land, and opportunities for operations on a larger scale, or for more diversity because of climatic conditions. Here even greater opportunities for greater production per worker become apparent through the use of more machines and facilities for livestock production.

More Product Per Hour of Work

Agriculture has gone hand in hand with industry in cutting the number of hours used to produce a unit of product. According to Fabricant,[4] practically every industry engaged in extraction, fabrica-

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[4] Solomon Fabricant, Labor Savings in American Industry, 1899–1939, Occasional Paper 23, National Bureau of Economic Research, Nov. 1945.

tion, power production, transportation, and communication reduced its man-hour requirements per unit of product during the period, 1899–1939. The great majority also reduced the number of workers employed per unit. The average reduction in workers per unit of product for all these industries combined was about 58 percent. When labor input is measured by man-hours it is about 65 percent. Both percentages probably understate the decline as they do not take full account of the improved quality of product and they ignore the great economies in material and fuel consumption.

Considering our total economy, including agriculture, the decline from 1899 to 1939 in persons employed, including the self-employed, per unit of product was about 40 percent. In terms of national product per worker the increase during the 40-year period was 70 percent. This does not represent the total gain from increased productivity because hours of labor per week declined. In terms of output per man-hour, the increase in productivity was about 100 percent.

As the purpose of this discussion is to show the effect of mechanization on gross farm production and farm output per hour of farm work, several new estimates have been necessary. These have been made for periods for which basic data are available, beginning with 1909–13, and for each year from 1939 to 1945, inclusive.

TABLE 7.—*Gross farm production, farm output, and man-hour requirements, United States, selected periods and years, 1909 to 1945*

[For indexes, 1917–21 = 100]

Period or year	Gross farm production	Farm output	Man-hour requirements [1]		Man-hours per unit of—		Gross production per hour	Farm output per hour
					Gross production	Farm output		
	Index	*Index*	*Million hours*	*Index*	*Index*	*Index*	*Index*	*Index*
1909–13	93	93	22,262	97	104	104	96	96
1917–21	100	100	22,983	100	100	100	100	100
1927–31	107	116	22,193	97	91	84	110	120
1939	111	126	20,454	89	80	71	125	142
1940	113	130	20,412	89	79	68	127	146
1941	117	136	20,617	90	77	57	130	151
1942	129	150	21,132	92	71	61	140	163
1943	126	147	21,026	91	73	63	137	160
1944	131	154	21,182	92	70	60	142	167
1945	130	153	20,655	90	69	59	144	170
Percentage change:								
1917–21–1939	11	26	−11	....	−20	−29	25	42
1939–44	18	22	3	....	−12	−15	14	18
1939–45	17	21	1	....	−14	−17	15	20

[1] See footnote 2, table 5.

During the war and postwar years of 1917–21, an average of nearly 23 billion man-hours were required annually in the operation of farms of the United States. In the later war years, 1942–45, an average of about 21 billion hours were required. While this decrease of about 9 percent in total man-hours was occurring, gross agricultural production increased 29 percent, and farm output for human use increased 51 percent (table 7). The combination of increased production with

fewer man-hours meant that during World War II it took only 71 percent as many man-hours to produce a unit of gross production as during the period 1917–21. Looked at another way, 1 hour of man labor produced about 41 percent more gross product in 1942–45 than in 1917–21. The increase in farm output for human consumption per hour of man labor was considerably greater, amounting to 65 percent.

Different degrees of change are apparent when these changes are considered separately for the period, 1917–21 to 1939, and for the period 1939–45 (table 7). The 21-year inter-war period was an extended period of farm mechanization, and a large part of the increase in gross production per hour was caused by increases in power machines for field and road work, as is shown later. From 1939 to 1945, gross production increased considerably more than during the previous 21 years. But total man-hours required in farm operation did not decrease—instead they increased 1 percent. Gross production per man-hour increased 60 percent as much in this short period as the increase in the previous 21 years. Increased yields per acre and per animal, as well as increased mechanization, were influential in increasing production per hour of labor, especially during World War II.

TABLE 8.—*Man-hour requirements per unit of production for selected farm products, United States, selected periods and years, 1917–44*
[Index numbers (1917–21 = 100)] [1]

Product	1917–21	1927–31	1939	1942	1943	1944	Percentage change	
							1917–21 to 1939	1939 to 1944
Milk..................	100	87	86	81	80	78	−14	−9
Meat animals.......	100	93	85	83	81	78	....	−8
Poultry.............	100	94	90	85	82	85	−10	−6
Total meat animals and animal products.	100	91	88	81	78	78	−12	[2] −11
Feed and food grains.	100	85	74	58	64	60	−26	−19
Cotton.............	100	84	66	62	62	58	−34	−12
All truck crops......	100	85	79	77	79	73	−21	−8
Vegetables except truck............	100	78	74	65	66	67	−26	−9
Total crops.....	100	90	76	66	69	66	−24	−13
Gross farm production.............	100	91	80	71	73	70	−20	−12
Farm output........	100	84	71	61	63	60	−29	−15

[1] 1919–21 production used; data not available for 1917–21.
[2] The percentage decrease in hours per unit of production of all livestock was larger than for any class of livestock shown because of changes in the relative importance of the individual livestock items. Poultry and meat-animal production, which requires less than one-half as much labor per unit of product as does milk, increased much more than milk production from 1939 to 1944.

The largest decrease in man-hours per unit of production was for cotton from 1917–21 to 1944, and for feed and food grains from 1939 to 1944 (table 8). In the first instance the decrease was due largely to increased cotton yields, which required little more labor per acre for preharvest work, and to some increase in mechanization in preharvest and harvest work. Cotton yields averaged 163 pounds per acre in 1917–21 when yields were low because of excessive boll weevil damage, and

238 pounds per acre in 1939 when the greatly reduced cotton acreage consisted of the more productive lands. Food-grain production was mechanized considerably before World War II. The practice of combine-harvesting, or "combining," instead of binding and threshing food grains continued to expand in World War II, and hours per unit of corn were cut drastically by greater use of mechanical corn pickers and by picking corn from the standing stalk in areas that previously harvested by cutting, shocking, and hand husking from the shock. Hours per unit of production of truck and vegetable crops were reduced about as much as they were for feed and food grains in the period 1917–21 to 1939. Preharvest jobs for these crops, and to some extent harvest jobs, were mechanized during that period.

TABLE 9.—*Estimated "labor savings" in farm production resulting from changes in mechanization, crop yields, and other factors since 1917–21, United States*

Item	Man-hours saved in *1944* production because of changes in methods and practices since 1917–21		Man-hours saved in *1939* production because of changes in methods and practices since 1917–21		Man-hours saved between 1939 and 1944 because of changes in methods and practices since 1917–21	
	Millions	*Percent*	*Millions*	*Percent*	*Millions*	*Percent*
Savings because of *increased mechanization* including decrease in horse and mule numbers:						
Totals....................	4,200	48	3,000	60	1,200	30
Averages per year...........	168	....	150	....	240	....
Savings of preharvest and harvest labor because of *increased yields:*						
Totals....................	1,700	19	850	17	850	21
Averages per year...........	68	....	42	....	170	....
Savings in livestock labor because of *increase in size of enterprise, increased production per animal, etc.:*						
Totals....................	1,200	13	550	11	650	16
Averages per year...........	48	....	28	....	130	....
Savings because of *spreading* of *overhead labor over larger volume of production:*						
Totals....................	650	7	100	2	550	14
Averages per year...........	26	....	5	....	110	....
Savings because of shifts in importance of *labor intensive and labor extensive enterprises:* [1]						
Totals....................	(600) [2]	(7) [2]	(600) [2]	(12) [2]	0	0
Averages per year...........	(24) [2]	....	(30) [2]	....	0	....
Miscellaneous savings because of *change in method, elimination of operations, work simplification,* increase in some custom-hired operations, etc.:						
Totals....................	1,850	20	1,100	22	750	19
Averages per year...........	74	....	55	....	150	....
Totals....................	9,000	100	5,000	100	4,000	100
Averages per year...........	360	....	250	....	800	....

[1] Production of enterprises in 1919–21 used in making estimates. Data not available for 1917 and 1918.
[2] Increases instead of savings. To be subtracted from the sum of the other items.

Reduction in the number of man-hours required to produce a unit of meat animals and animal products was only half as great from 1917-21 to 1939 as the reduction in hours per unit of crop production—12 percent and 24 percent respectively (table 8). In the 6 wartime years, 1939–44, the decrease in hours per unit of livestock production was nearly as large as the total decrease for the 20 years from 1917–21 to 1939. More milking machines and better barn and barnyard facilities and equipment helped to reduce man-hours per unit of livestock production. But higher milk production per cow, higher egg production per hen, and higher hog, cattle and sheep production per unit of breeding stock probably were also important, especially during the war.

Decreases in the hours per unit of farm output were somewhat larger than the decreases for gross farm production, because of the continued decrease in horse and mule numbers on farms since 1918 (table 8).

If all farmers in the United States had farmed in 1944 as they did in 1917–21—that is, had used the same machines and tools and the same power units—and produced their crops and livestock in about the same proportions and at the same rates of yield, the larger volume of gross production in 1944 would have required 9 billion more man-hours than were actually required (table 9).[5] Without this saving in man-hour requirements our 1944 farm production would have required about 30 billion man-hours instead of 21 billion hours. In terms of man-years of 2,000 hours each, $4\frac{1}{2}$ million more farm workers would have been needed to do the 1944 production job if our farmers had

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[5] In 1944, gross farm production amounted to 11.2 billion dollars at average 1935–39 prices. Counting 100 dollars as a unit of production, gross production in the last full year of war totaled 112 million units. About 189 man-hours of farm labor (including farm-maintenance labor) were required for each unit of production in 1944. In 1939, about 215 man-hours were required for each of the 95 million units of production. Gross production averaged 86 million units in the period 1917–21 and each unit required 269 man-hours.

Total labor savings, as used in this publication, are a function of reduced man-hours per unit of production and total volume of production in the year for which total savings are estimated. Thus in 1944 each unit of production required about 80 fewer hours of labor than in the 1917-21 period; a saving of 80 hours per unit applied to the 112 million units produced in 1944 results in total savings of approximately 9 billion hours. This means that if the 1944 volume of production had been produced with the methods and practices, and at the same level of yields, as characterized the 1917-21 period, 9 billion additional man-hours of labor would have been required. Stated in another way, if total man-hour requirements had increased from 1917-21 to 1944 by the same percentage as total units of production increased, total man-hour requirements in 1944 would have been 9 billion more than actually was the case.

With the practices, methods, and yields that prevailed in 1939, each unit of production required 54 fewer hours than in 1917-21. This saving of 54 hours per unit applied to the 95 million units of production in 1939 resulted in a total labor saving of approximately 5 billion hours. Again this means that if total man-hour requirements had increased by the same percentage as gross production increased from 1917-21 to 1939, total man-hours in 1939 would have been about 5 billion more than actually were required in 1939.

The difference between the 9 billion hours of savings for the entire period, 1917–21 to 1944, and the 5 billion hours of savings from 1917–21 to 1939 is 4 billion hours. This means that 55 percent of the total saving of 9 billion hours had already been attained by 1939, and that 45 percent of the total savings came between 1939 and 1944.

In summary, savings for the entire 25-year period and the two sub-periods are measured from a common base of 1917–21. From this common base period to 1944 there was a saving of 80 man-hours per unit of production on 112 million units produced in 1944. Most of this saving, or approximately 5 billion hours, had occurred by 1939 when 95 million units were produced with 54 fewer hours per unit than would have been required under 1917–21 production conditions.

been using the farm power, machines, and production practices that were in common use in 1917–21.

A combination of several other developments has been even a little more effective than farm mechanization in reducing man-hours per unit of farm production. Savings in man-hours, as defined above, because of farm mechanization, from 1917–21 to 1944 amounted to 48 percent of total savings from all developments. The remaining 52 percent of the total was composed principally of savings because of increased production per acre of cropland, increase in size of livestock enterprise, increase in production per animal, spreading of overhead over a larger business, and several other factors. These others included changes in methods of handling enterprises, elimination of operations, work-simplification features, and increase in some custom-hired operations. Total savings from these items plus those from mechanization amounted to 9.6 billion hours. But the net savings were only 9 billion hours because of an increase of 600 million hours as a result of shifts in production to more intensive labor-using crops and livestock.

Private and governmental research, and farmer experimentation and adoption, have been responsible for technological developments that have brought about more production from each hour of farm work. Engineers, plant breeders, animal breeders, agronomists, pathologists, chemists, entomologists, and others have contributed to increased farm mechanization and increased production per acre and per animal. Both mechanization and increased production have increased production per hour of labor.

TABLE 10.—*Approximate importance of various types of machines responsible for "labor savings" in agriculture, 1917–21 to 1944*

Item	Approximate increase in number of machines on farms 1917–21 to 1944	Approximate number of man-hours saved by increase in mechanization, 1917–21 to 1944
	Thousands	*Thousands*
Tractor-operated plows, listers, middlebusters, disk harrows, field tillers, cultivators, row-crop planters, and grain drills..............................	5,200	380,000
Tractor-operated grain combines, corn pickers, grain binders, and row-crop binders......................	900	400,000
Tractor-operated mowing machines and pick-up balers...	450	60,000
Tractor-operated miscellaneous equipment.	....	100,000
Farm automobiles and motortrucks..................	3,400	1,400,000
Manure spreaders, small tools and gadgets, increase in size of horse-drawn equipment in some areas, increase in machine over hand work in planting, hay-making, etc., better and more convenient gates, fencing, storage, etc..	....	700,000
Milking machines.................................	300	220,000
Other savings on meat animals and animal products.....	....	60,000
Net savings in chore work on horses and mules because of displacement by mechanical equipment (horse and mule chores, minus farm maintenance work on tractors, autos, trucks, and other farm machinery and equipment)...	....	880,000
Total...............................	....	4,200,000

Of the 4.2 billion man-hours saved because of farm mechanization, 1.4 billion, or one-third, were saved by an increase of 3.4 million farm automobiles and trucks (table 10). These transportation vehicles, with the good roads that accompanied their increase in numbers, enable farmers to haul livestock and other farm products to market and to haul supplies home, in only a fraction of the time it took when livestock were moved on foot and horse-drawn vehicles and dirt roads were the rule. Savings in hauling on the farm have been made. On the average, each automobile or truck saves the farmer more than 400 man-hours a year, compared with the time it would take to do the same hauling with horses and mules. As only one-half of the automobile use was considered farm business and so was included in these computations, other worth-while savings have been made in the time spent on personal matters.

Horses and mules disappeared between 1917–21 and 1944 by more than 13 million head. Savings in chores involved in caring for these animals amounts to 880 million man-hours, after deducting the additional farm time for caring for the tractors, motor vehicles, and other machinery that displaced them. A part of this saving has come from the fact that more servicing of tractors, automobiles, and trucks is now done by town and city workers whereas chore work on farm horses and mules has always been done on the farms.

The actual decrease in chore labor on horses and mules during the 25-year period approximated 1,130 million man-hours. This decrease was brought about by the disappearance of 13 million head of horses and mules from farms and by a decrease in the time spent in caring for each animal. Not all of this gross saving in man-hours was available for producing food and fiber for human use because of an increase of 250 million farm man-hours used in caring for more motor vehicles and other farm machinery. The difference between the two, or the net saving, was 880 million hours. Farm maintenance of automobiles and motortrucks required 145 million of the 250 million hours, and farm maintenance of tractors and other machinery required the remainder, or 105 million hours. About 760 of the total net savings of 880 million hours was attributed to the added tractors and tractor equipment, and the remainder, or 120 million hours, to the fast-growing numbers of farm trucks and automobiles.

In 1944, tractor-operated equipment for field operations—such as seedbed preparation, seeding, cultivating, and harvesting crops—and for doing miscellaneous farm jobs reduced man-hours below those which would be required with teams, by 940 million hours. This, added to the net decrease of 760 million hours used in caring for fewer horses and mules, amounts to 1.7 billion hours. As tractors on farms increased from 1917–21 to 1944 by about 2 million, the yearly saving per tractor has been about 850 man-hours.

Milking machines added to farm equipment over the 25-year period saved farmers 220 million hours in 1944. Manure spreaders, and the numerous small tools and conveniences introduced on farms since 1917–21, lowered man-hours in 1944 from what they would have been if farmers were still farming as they were in 1917–21 by 700 million.

Most of these savings in time because of mechanization, (55 percent) have been made in growing, harvesting, and hauling crops. Twenty-

six percent of the total was reduced chore work on horses and mules, 15 percent on meat animals and animal products, and 4 percent of the savings because of mechanization were on general maintenance of farm plant.

Savings in labor because of increased yields from 1917–21 to 1944 amounted to 1.7 billion hours (table 9). Most of this saving was in the form of preharvest crop labor. If acre yields had remained as they were in 1917–21, farmers would have needed about 69 million more average acres to produce the 1944 volume of production than were actually used. Seedbed preparation, seeding, and cultivating these 69 million acres with 1944 equipment and power would have taken about 1.5 billion more man-hours than were required on the smaller acreage actually used. Nearly 85 percent of these 1.5 billion preharvest hours on the large acreage would have been for cotton, corn, truck crops, and tobacco; nearly 50 percent would have been for cotton alone. Thus, these crops were largely responsible for the savings in hours of preharvest work due to increase in yields. The percentage increase in yields per acre, 1944 over 1917–21 average, were about as follows: Cotton, 80 percent; tobacco, 35 percent; wheat, 35 percent; and corn 20 percent. All crop production per acre was about 25 percent higher in 1944 than in 1917–21.

About 170 million hours were saved in the harvest work of 1944 production because of the increase in yields of crops over the 1917–21 average. Particularly in the case of crops whose harvest operations are mechanized, an increase in yield does not result in a proportional increase in hours required for harvesting—it results in decreased harvest-labor requirements per unit of production. Relatively less saving in harvest labor per unit results from increased yields of such crops as cotton, tobacco, or truck crops, whose harvest involves primarily hand labor. Of the total savings in harvest labor due to increased yields from 1917–21 to 1944, about three-fourths were made on the wheat and corn crops.

The volume of meat animals and animal products that was produced in 1944 would have required 1.2 billion more man-hours than were required had it not been for the increase in size of livestock enterprises and the increase in production per animal compared with the 1917–21 average. There were more milk cows per farm in 1944, and milk production per cow had increased 21 percent during the period. A decreasing number of man-hours are required to produce 100 pounds of milk as cow numbers in the herd increase and as production per cow increases.

Egg production has become more specialized, and egg production per hen has increased during the same period by 27 percent, and considerably less labor is now required to produce a dozen eggs. Commercialized broiler and turkey production in recent years has helped to reduce the man-hours used to produce a hundred pounds of chicken and turkey meat. More hogs per farm, better sanitation, and more attention to saving pigs have reduced losses of both pigs and more mature animals. Housing, feeding, and watering conveniences mean fewer hours required to produce 100 pounds of hogs. It takes less labor to produce a given quantity of beef, lamb, and wool than it did 25 years ago. All combined, production of meat animals and animal products has increased much faster than have the numbers of breeding stock. (See table 37 in the appendix).

The volume of agricultural production increased at a more rapid rate between 1917–21 and 1944 than did general farm-maintenance labor or overhead, and production in 1944 required 650 million fewer overhead hours than the same volume of production would have required in 1917–21 (table 9). More production per hour of labor spent in maintenance and repair of buildings, fences, and machinery accounted for most of the overhead savings in labor per unit of farm production.

About 100 million units of agricultural production, exclusive of product added by horses and mules, pastures, and a few miscellaneous crops, were produced in 1944.[6] If this 1944 production had been of the same composition as the production of 1917–21, it would have taken 160 direct hours, exclusive of indirect farm-maintenance labor, to produce one unit of 1944 production. Actually, because of change in composition, 166 direct hours were required in 1944 to produce a unit of production. Thus, because of change in composition, it took 6 more hours per unit of production, or a total of 600 million more hours to produce the 100 million units of production.

Two groups of products contributed to the plus side of the net increase of 600 million hours. One group—composed of milk, truck crops, and tobacco—whose production increased more than the average and whose labor requirements per unit of production were larger than the average for all commodities, contributed a plus of 387 million hours (table 11). Milk was the most important contributor in the group. This was due to the relatively large increase in milk production— 60 percent—compared with the average increase of about 36 percent for all commodities, and to the high labor requirements per unit of product—398—compared with 160 for all products.

The second group consists of food and feed grains, hay, and vegetables, excluding truck. This group contributed 471 million hours to the plus side of the total. But unlike the first group, production of the commodities in group 2 increased less than average, and the commodities required less than average amounts of labor per unit of production. The influence here is indirect in that the lower rate of increase made available more of all production resources for commodities that required above-average labor per unit of production. Food and feed grains combined made the dominating item in this group. Food and feed grains production increased from 1917–21 to 1944 by only 14 percent, compared with the average increase for all commodities of 36 percent, and only 111 hours of labor were required in 1944 to produce 1 unit of production, compared with an average of 160 hours for all commodities.

The next two groups of commodities shown in table 11 contributed to the minus side of the net increase of 600 million hours. Cotton and sugar crops require much labor per unit of production but neither crop increased in production as much as the average increase of all commodities. Cotton production from 1917–21 to 1944 increased only

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[6] One hundred dollars' production in terms of 1935–39 average prices equals one unit of production. All of the labor savings through change in numbers of farm horses and mules were attributed to mechanization. "Product added" by horses and mules amounted to 3 million units of production in 1944. About 9 million units of production in the form of pastures and a few miscellaneous crops were omitted from this analysis because necessary data are lacking.

about one-third as much as the average, and production of the sugar crops decreased by 13 percent.

The second group that lowered the average labor requirements per unit of production consisted of meat animals, oil crops, poultry products, and fruits and nuts. Each of these require less than the average labor per unit of product, and their production increased at a much higher rate than the average increase for all commodities.

TABLE 11.—*Effect on "labor savings" of shifts in composition of production, 1917–21 to 1944*

Item	Labor requirements per unit of production, 1944 [1]	Increase in production, 1917–21 to 1944 [2]	Composition of production		Contribution to total "labor savings" because of change in relative composition
			1917–21 average [2]	1944	
	Hours	*Percent*	*Percent*	*Percent*	*Million hours*
Enterprises that raised average labor requirements per unit of all production:					
Enterprises with above-average requirements:					
Milk [3]	398	60	7.7	9.0	350
Truck crops	169	128	4.0	6.7	25
Tobacco	209	43	3.3	3.5	12
Enterprises with below-average requirements:					
Feed and food grains	111	14	40.7	34.1	338
Hay	105	14	10.1	8.5	100
Vegetables, except truck	88	23	4.2	3.8	33
Enterprises that lowered average labor requirements per unit of all production:					
Enterprises with above-average requirements:					
Cotton	274	13	8.7	7.2	−166
Sugar crops	252	[4]−13	1.1	.7	−38
Enterprises with below-average requirements:					
Meat animals [3]	144	53	9.8	10.9	−19
Oil crops	151	647	.5	2.6	−19
Poultry products [3]	156	90	5.9	8.2	−9
Fruits and nuts	151	63	4.0	4.8	−7
Average or total	[5]160	36	100.0	100.0	+600

[1] The unit of production is 100 average 1935–39 dollars.
[2] Averages for 1919–21 were used; data not available for 1917 and 1918.
[3] Production of livestock and livestock products was expressed in terms of "product added."
[4] A decrease.
[5] Weighted average, assuming that same composition of production existed in 1944 as in 1919–21.

Between 1917–21 and 1944 farmers reduced the hours required per unit of production in other ways. For example, a large part of the topping and stripping of blades from the corn stalks in the South for "bundle feed" has disappeared with the expansion of hay and other forage-crops. In some areas, there is less hand hoeing of corn and other row crops. Farm and building conveniences that save work are more

prevalent. Commercial haulers of grain, livestock, fruit, and other farm commodities have helped to reduce man-hours per unit of production. Prices paid for important supplies—as fertilizer, lime, feed, and building supplies—now frequently include delivery at the farm. Miscellaneous farm labor savings of this sort over the 25-year period are estimated at about 1.8 billion hours for a volume of farm production equal to that of 1944 (table 9).

Relatively large parts of the changes that have been described took place during the war period, 1939–44. For example, if all farmers had been farming in 1939 in the way they were in 1917–21, the 1939 volume of production would have required 5 billion more man-hours (table 9). This means that 4 billion of the 9 billion hours of "labor savings" were saved after 1939, and were possible principally because of increased yields, increased size of livestock enterprises, spreading of overhead over a larger volume of business, and increased use of farm machines. On a percentage basis, mechanization contributed less to labor savings during the war period, 1939–44, than in the longer interwar period, 1917–21 to 1939. In terms of hours per year, however, the savings were much larger during the war than in the earlier period.

TABLE 12.—*Estimated "labor savings" between 1939 and 1944 resulting from changes in farming methods and practices since 1917–21 and since 1939, United States totals*

Item	Man-hours saved between 1939 and 1944 by changes in methods and practices since 1917–21		Man-hours saved between 1939 and 1944 by changes in methods and practices since 1939	
	Million hours	*Percent*	*Million hours*	*Percent*
Savings because of *increased mechanization*, including decrease in horse and mule numbers..........	1,200	30	850	28
Savings of preharvest and harvest labor because of *increased yields*...............................	850	21	800	27
Savings in livestock labor because of *increase in size of enterprise, increased production per animal, etc.*....	650	16	550	18
Savings because of *spreading of overhead labor over larger volume of production*.....................	550	14	400	13
Savings because of shifts in importance of *labor intensive and labor extensive enterprises*.............	0	0	200	7
Miscellaneous savings because of *change in methods, elimination of operations, work simplification,* increase in custom-hired operations, etc..........	750	19	200	7
Total.........................	4,000	100	3,000	100

If the labor savings from 1939 to 1944 were measured from the base year 1939 instead of the base period 1917–21, the total would be only three-fourths as large, or 3 billion man-hours (table 12). Labor savings from increased mechanization would account for 28 percent of the total instead of 30 percent, and labor savings because of increased yields would be 27 percent instead of 21 percent. Wartime shifts to less labor-intensive crop and livestock enterprises brought greater savings during the war than in the prewar period.

More Food and Fiber for Human Consumption

The shift from animal power toward mechanical power on farms and in cities, towns, mines, etc., that started after World War I and continued through World War II has resulted in two important accomplishments. It has helped to reduce the farm-labor force needed and the

TABLE 13.—*Acreages of harvested crops used for specified purposes, United States, 1910–45*

Crop year beginning in	Crops harvested [1]	Acreages used for producing export products [2]	Acreages used for producing—				Total population July 1 [5]
			Feed for horses and mules [3]		Food, fiber, and tobacco for domestic consumption [4]		
			On farms	In cities, mines, etc.	Total	Per capita	
	Million acres	*Million acres*	*Million acres*	*Million acres*	*Million acres*	*Acres*	*Million*
1910	325	36	70	16	203	2.21	92
1911	330	40	72	15	203	2.16	94
1912	329	41	73	15	200	2.11	95
1913	333	42	74	15	202	2.08	97
1914	334	55	76	14	189	1.91	99
1915	340	47	77	14	202	2.00	101
1916	340	51	77	13	199	1.95	102
1917	349	42	78	12	217	2.11	103
1918	362	60	79	11	212	2.02	105
1919	364	54	79	10	221	2.10	105
1920	360	58	77	10	215	2.03	106
1921	359	64	77	8	210	1.93	109
1922	355	48	76	7	224	2.04	110
1923	354	46	76	6	226	2.02	112
1924	355	52	74	5	224	1.96	114
1925	360	43	72	4	241	2.08	116
1926	359	52	70	4	233	1.99	117
1927	358	48	68	3	239	2.01	119
1928	361	48	66	2	245	2.02	121
1929	365	42	64	2	257	2.11	122
1930	369	38	61	2	268	2.18	123
1931	365	35	60	1	269	2.17	124
1932	371	34	58	1	278	2.22	125
1933	340	27	56	1	256	2.03	126
1934	304	19	55	1	229	1.83	125
1935	345	20	53	1	271	2.13	127
1936	323	18	51	1	253	1.98	128
1937	347	28	50	1	268	2.08	129
1938	349	21	46	1	281	2.16	130
1939	330	23	43	1	263	2.01	131
1940	339	15	41	1	282	2.14	132
1941	342	15	38	1	288	2.17	133
1942	346	22	37	1	286	2.12	135
1943	355	37	37	1	280	2.06	136
1944	359	33	36	1	289	2.09	138
1945	355	35	34	1	285	2.04	140

[1] Area in 52 principal crops harvested or estimated equivalent plus acreages in fruits, tree nuts, and farm and market gardens.

[2] Crop exports from 1910 to 1939 are based on yields of specified year applied to gross exports for year beginning July 1, or month representing beginning of crop season. Acreages for livestock exports from 1910 to 1939 are based on average crop yields for 1935–39, and are for the year beginning July 1. Acreages for exports and lend lease from 1940 to 1945 for both crops and livestock are based on 1940-43 average crop yields.

[3] Feed computations for horses and mules are based on United States average yields of corn, oats, and all hays. From 1910 to 1919 the calculations allow 800 pounds of oats, 1,600 pounds of shelled corn, and 1.8 tons of hay per head for farm horses and mules 3 years old and over, and animal-unit equivalents for younger animals. Beginning with 1920, it was assumed that the rate of feeding corn declined 10 pounds per head annually and the rate of feeding hay increased 20 pounds. For nonfarm horses and mules the quantity of grain and hay fed per head annually was estimated to average about one-third more than for farm horses and mules.

[4] Includes products used by our military forces in this country and abroad, and by our domestic civilian population.

[5] Includes persons in our military forces in this country and abroad.

time required to produce a unit of farm product, and it has diverted land and other resources from the production of feed for horses and mules to the production of food for human consumption. Nine million crop acres were thus released during the 6 high-yielding wartime years alone, and 55 million crop acres were so released during the 27 years since horse and mule numbers reached a peak in 1918 (table 13). The total released acreage would have been larger if yields of feed crops had not increased so substantially during World War II. Feed from large acreages of pasture land has been diverted also from maintenance of workstock to the production of livestock food for human use.

After allowing for acreages used to grow products for export, lend lease, and feed for horses and mules, the acreages for producing products for domestic consumption have averaged, during 1940–45, about 2.10 acres per capita, varying annually to some extent because of variations in crop yields. During the 1940–45 harvest seasons production per acre of cropland averaged considerably above the 1935–39 average. In addition, the per capita use of these higher yielding acres was somewhat greater than the average acreage used in 1935–39.

TABLE 14.—*Changes in acreages of harvested crops used for specified purposes, 1918–22 to 1940–44, United States averages*

Crop acreages and population	1918–22 averages	1940–44 averages	Change from 1918–22 to 1940–44	
			Number	*Percent*
Crop acreages harvested:				
Total..........million acres..	360.0	348.2	−11.8	−3
For export crops..........do...	56.8	24.4	−32.4	−57
For horse and mule feed...do...	86.8	38.8	−48.0	−55
For domestic use..........do...	216.4	285.0	+68.6	+32
For domestic use ....acres per capita..	2.0	2.1	+.1	+5
Population..........millions..	107.0	134.8	+27.8	+26

The wartime per capita acreages listed in table 13 include the acreages used to grow the tremendous wartime supplies of food, fibre, and tobac.co that were used by our armed forces and in the making of munitions Some of the acreage was used for supplies that were diverted from military stocks to allied military and civilian uses, and to feeding civilians in occupied countries and prisoners of war. Large losses of agricultural products that occured in transit and the accumulation of military stocks before the ending of the war are also included in the per capita acreages. If correct allowances could be made for all these "exceptional" disappearances of food, fiber, and tobacco during the

war, the average crop acreage per capita would be reduced to something less than 2. But owing to the greater wartime crop and livestock yields, per capita consumption actually averaged 7 to 8 percent higher than that of 1935–39.

Horse and mule numbers in the United States increased until 1918, and acreages used for growing grain and forage for them were at their height at that time. Thereafter, their continuous decline has released more and more crop and pasture land for producing food, fiber, and tobacco for market. Comparisons of the two 5-year periods, 1918–22 and 1940–44—both periods of high farm and industrial activity—show the sources of increased production to feed and clothe our increasing population (table 14). During 1940–44 total population in the United States averaged 26 percent larger than during 1918–22, and on an average each person in the later period consumed at least 10 percent more farm products than in the earlier period. During the same time harvested crop acreages for *all uses* decreased about 3 percent.

There are three noteworthy reasons why our increased population has been fed and clothed better from less land. In the first place, crop yields were considerably higher in the recent war years than in the period, 1918–22. In the second place, fewer acres were needed to grow horse and mule feed. In the third place, fewer acres were needed to produce our export and lend lease products in 1940–44 compared with 1918–22. In terms of percentages, more than 50 percent of the increased production used by our larger population is explained by larger crop and livestock yields, about 30 percent by a decrease in crop acreages required for feeding farm and off farm horses and mules, and about 20 percent in decreased acreages required for producing products for export or lend lease.
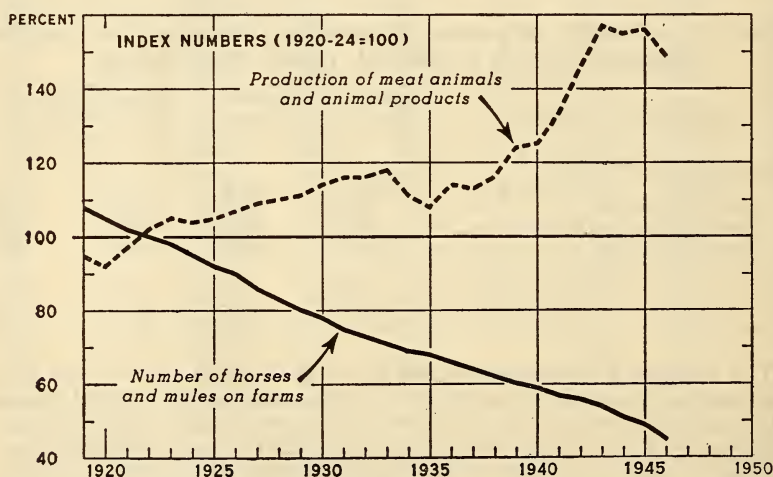
FIGURE 3—HORSE AND MULE NUMBERS ON FARMS, AND VOLUME OF PRODUCTION OF MEAT ANIMALS AND ANIMAL PRODUCTS, UNITED STATES, 1919-46.

Feed supplies released because of the decline in horse and mule numbers have contributed to the increase since 1919 in supplies of meat animals and animal products for human consumption.

Although crop yields and the composition of crop and livestock production have varied over the 35-year period, the general tendency since 1918 has been for the production of meat animals and animal products, including poultry and dairy, to increase somewhat in proportion to the decrease in horse and mule numbers (fig. 3).

The dip from normal in the production trend of meat animals and animal products which occurred in the 1930's was caused by severe drought in large areas and by Government restrictions of livestock production because of depression prices. Ever-normal granaries of feed crops that were built up in the periods of low demand for meat, eggs, butter, and milk were used later on in the succeeding war period to aid in providing exceptionally large supplies of livestock and livestock products for use both here and abroad.

The cost of raising and keeping farm work animals represents farm-produced power. Measured in 1935–39 average dollars, the volume of farm-produced power reached a peak of nearly 2 billion dollars in 1918 and then fell steadily to less than one-half of that volume in 1945. By 1945 farm-produced power made up only 7.4 percent of total gross farm production, compared with about 21 percent of the total gross production realized during 1910–14 (table 15).

TABLE 15.—*Gross farm production and farm-produced power, specified periods and years, United States, 1910–45*

Period	Gross farm production [1]	Farm-produced power [2]	
		Amount	Proportion of gross production
	Million dollars [3]	*Million dollars* [3]	*Percent*
Average:			
1910–14............................	8,105	1,714	21.1
1915–19............................	8,522	1,861	21.8
1920–24............................	8,758	1,713	19.6
1925–29............................	9,103	1,453	16.0
1930–34............................	8,735	1,222	14.0
1935–39............................	9,060	1,083	12.0
1940–44............................	10,567	947	9.0
1940................................	9,724	1,002	10.3
1941................................	10,052	977	9.7
1942................................	11,045	947	8.6
1943................................	10,796	910	8.4
1944................................	11,206	868	7.7
1945................................	11,145	823	7.4

[1] Gross farm production measures calendar-year production of all crops, pasture consumed by all livestock, and the product added in the conversion of feed and pasture into livestock and livestock products for human use and into farm-produced horse and mule power.

[2] Farm-produced power is the cost, in average 1935–39 dollars, of raising and maintaining farm horses and mules.

[3] Average 1935–39 dollars.

Thus, the land, labor, and equipment formerly used to produce more than 1 billion dollars worth of animal farm power (1935–39 dollars) became available during World War II for producing commodities for human consumption. Farm output, or roughly, that part of gross farm production that is available for human use, however,

increased much more during the war than farm-produced power decreased. Greater use of fertilizers and improved strains and varieties of seeds, and favorable weather, brought unusually good crop yields and more abundant feed and pasture crops for livestock. But owing to the large supplies of labor-saving machines on farms, and even with considerably less farm labor, these larger wartime crops were harvested, stored, and hauled to market with little loss from spoilage.

Less Hand Labor Needed

Farming requires hard work, much of which is done with the hands or with small hand tools. Of the 21.2 billion man-hours spent on farms in 1944, approximately 60 percent, or 13.0 billion hours were done with the hands or with small hand tools—ax, pitchfork, shovel, hoe, husking peg, pruning knife. It is significant that this high percentage of hand labor remains after a hundred years of substitution of mechanical or animal power for human power (table 16).

Further mechanization of farm jobs will reduce the hand work used in agriculture. It may eliminate another 2 or 3 billion hand hours within the next decade, providing mechanical cotton pickers come into general use, and providing the general trend of eliminating hand jobs during the last 10 years is speeded up. This total seems now to be an outside possibility, with considerable chance that the actual elimination will be appreciably less. An elimination of 2 or 3 billion hours of hand labor probably would mean a net reduction of one-third to one-half as many hours. A part of the direct savings in labor occasioned by changing from hand tools to power tools is offset by additional hours used in caring for the more complicated tools and machines. In exceptional cases the total hours per unit of product may be almost as great with machines as with hand tools; the real advantages then come from doing the job more quickly and with less effort.

The greatest need for hand work is in the care of livestock. At present, 75 percent of the man-hours in livestock work on farms is hand labor, and more than one-third of all work on farms is caring for livestock (table 16). A further reduction of 17 percent in the hours of hand work spent on livestock would result in a decrease of 5 to 8 percent in all man-hours now spent on livestock on farms. To eliminate more hand labor in livestock care would mean more and better feeding and watering conveniences, more mechanization in handling manure in the barns, more use of milking machines, etc. With greater coverage in rural electrification, these things will be possible. There will remain, however, the 2 to 3 million small farms with only a few head each of the different kinds of livestock. Here, electrically operated water pumps will eliminate a lot of hand labor in watering the livestock but hand milking will continue on most of the 3.5 to 4 million farms that have 9 or less cows per farm.

In 1944, nearly one-half of the 21 billion hours spent in farm work were devoted directly to crops. Nearly one-half (47 percent) of these hours was hand work. It was relatively heavy on such crops as fruits, vegetables, tobacco, cotton, potatoes, and peanuts. Thirty-one percent of the 2.6 billion man-hours used in growing and harvesting corn were hand-hours, and even in wheat production nearly one-fourth of the man-hours in 1944 was hand labor.

TABLE 16.—*Estimated total number of man-hours, and hours of hand labor used on farms in 1944, and possible reduction in hours of hand labor in next 10 years*

Item	Total number of man hours, 1944	Hours of hand labor [1]			
		Hours in 1944		Possible hours by 1954 [2]	Possible reduction in hand labor, 1944–54
		Number	Percent of total hours		
	Millions	*Millions*	*Percent*	*Millions*	*Percent*
Wheat..........................	500	115	23	75	35
Other food grains.................	88	22	25	16	26
Corn..........................	2,552	791	31	511	35
Other feed grains.................	734	183	25	122	33
Hay and grass seeds, exclusive of grain hays......................	918	314	34	230	27
Peanuts.......................	240	110	46	72	34
Soybeans and flaxseed.............	157	24	15	16	33
Tobacco.......................	733	527	72	366	31
Cotton.........................	2,001	1,101	55	560	49
Potatoes.......................	198	103	52	85	17
Dry beans and peas...............	50	6	12	5	17
Other vegetables.................	1,244	837	67	628	25
Sugar beets and cane.............	115	71	62	52	27
Sorgo, cane, and maple sirup crops..	71	53	75	46	13
Fruits and nuts..................	741	563	76	460	18
Miscellaneous crops...............	94	55	59	37	33
Total crops................	10,436	4,875	47	3,281	33
Dairy cows.....................	3,640	2,657	73	2,111	21
Other cattle....................	741	430	58	370	14
Hogs..........................	623	486	78	362	25
Poultry and eggs.................	1,430	1,124	79	981	13
Sheep, lambs, and wool...........	237	190	80	166	13
Horses and mules................	862	776	90	690	11
Total livestock..............	7,533	5,663	75	4,680	17
Farm maintenance...............	3,212	2,474	77	2,249	9
Grand total................	21,181	13,012	61	10,210	22

[1] Hours of hand labor, as used here, are hours worked with hands or with hand tools. The cutting and trimming, loading and unloading of trees for firewood is hand labor. Cutting the wood into stove lengths with a crosscut saw is hand labor; with a buzz saw, machine labor. Driving a wagon in hay harvest is not hand labor, but pitching on the hay or loading after a hay loader, is hand labor. Loading and unloading manure with a pitchfork is hand labor; if a manure spreader is used the unloading is not hand. Operating a pick-up hay baler is not hand labor, but the men who pick up the bales in loading them are doing hand labor. Much hand work is used in shocking, hauling, and threshing grain; little is used in combining grain.

[2] This date is used merely as a convenience in indicating a lapse of 10 years.

Further mechanization of harvesting small grains in the East, cotton, hay, sugar beets, potatoes, and corn, will reduce hand work substantially, and as the machines used in harvesting most of these crops are labor savers, mechanization will also reduce the total man-hours. It may be possible in the next 10 years to cut the hand labor used in crop production by one-third. But this can be done only if a large part of the cotton crop is mechanized in preharvest and harvest work, if combining is increased substantially in the East and South, if corn

pickers come into much greater use, and if hay-making methods are generally adopted that will eliminate pitching and hand loading of hay, and hand work at the barns and stacks and in the mows. It can be done only if many operations on small farms as well as on large farms are mechanized.

The least opportunity for eliminating crop hand work is for such crops as fruits, berries, nuts, vegetables, tobacco, and potatoes. Most of the crops in these groups must be handled carefully, and in some instances must be packaged in a way that will conserve their attractiveness and quality. Farm-maintenance work, amounting to about 15 percent of all farm labor, is mostly hand work. The hammer, saw, and trowel are principal tools in the erection and maintenance of farm buildings. Similar hand tools are used for cutting posts, building and repairing fences, and keeping machines and tools in order. These activities are not so susceptible to mechanization as are harvesting wheat, picking corn, harvesting hay, digging potatoes, milking cows, and pumping water.

Possibilities of reducing hand-hours by other means than mechanization are very great. Undoubtedly many of the 13 billion hand-hours are performed because of poor hand tools—a dull ax or saw, a worn-out hand tool, unsuitable hand tools for the jobs, etc. Poorly arranged buildings and feeding devices may double the time it takes to do the chores.

Recent farm-work simplification studies have indicated extensive possibilities in reducing hand-hours, and in doing the jobs with less effort, by scientific application of the laws of hand motion. The time required to do such hand jobs as setting plants, cutting seed potatoes, harvesting tobacco, harvesting celery, and tending livestock has been cut from 20 to 50 percent in conducted experiments. In one instance a Vermont dairy farmer, in cooperation with the Vermont Agricultural Experiment Station,[7] by making a series of inexpensive changes in and around his dairy barn, cut the time to tend 22 dairy cows by about 2 hours per day, and reduced the distance walked by 2 miles a day.

All hand jobs are not subject to such labor reductions. The time required to load hay of a given yield when a hay loader is used is governed by the speed with which the hay comes onto the wagon, but the time required to pick a bushel of tomatoes of a given yield is influenced by the waste motion of the picker. It seems probable that by far the greatest reduction in man-hour requirements so far has come about through increased use of improved machines. The 13 billion hand-hours in agriculture offer a large and profitable field for future savings through better arrangements of working facilities, better hand tools, and less waste motion in doing specific jobs.

CHANGES IN PATTERN OF MECHANIZATION

On January 1, 1910, the value of machinery on farms, including automobiles, tractors, and motortrucks amounted to more than 1.2 billions of dollars; on January 1, 1946 all machinery on farms was valued at about 6.3 billions of dollars, an increase of about 400 percent.

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[7] Carter, R. M. Labor Saving Through Farm Job Analysis (Dairy Barn Chores). Vt. Agr. Expt. Sta. Bul. 503. June 1943.

This remarkable upward trend in inventory values of farm machinery was accentuated sharply during the first and second World War periods, and was slowed down considerably during the depression years of the 1930's (fig. 4).
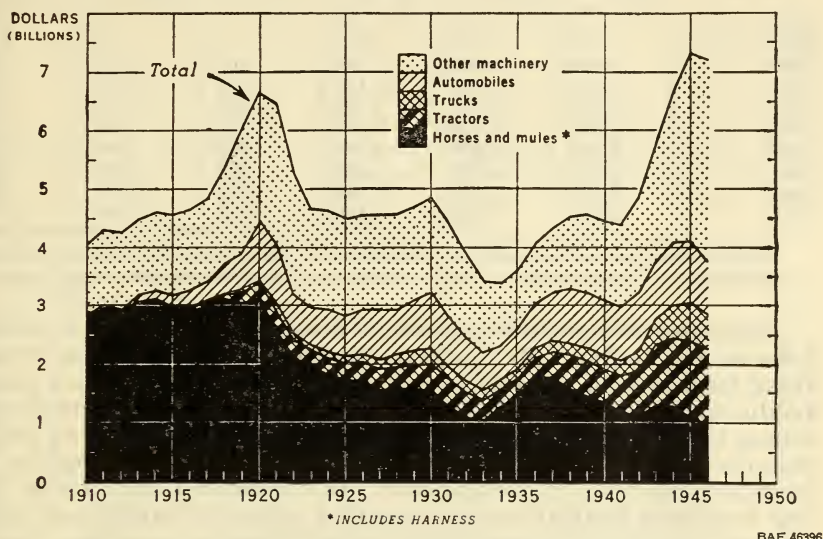
FIGURE 4—INVENTORY VALUES OF FARM HORSES AND MULES, AND FARM MACHINERY, JANUARY 1, UNITED STATES, 1910-46. (VALUE IN CURRENT DOLLARS)

Increasing values of automobiles, tractors, and motortrucks have largely offset the declining total value of all horses and mules on farms.

Although price levels at various stages of the upward swing over the 35-year period influenced total values, by far the greatest change was caused by the increase in automobiles, tractors, and trucks which, as a group, rose in value from practically nothing in 1910 to a peak of 3 billion dollars on January 1, 1945. By January 1, 1930, farm automobiles had risen to 96 percent of the 1942 numbers—the highest number ever recorded for our country. The number of motortrucks on farms at the beginning of 1930 was large also—about 60 percent of the high number of January 1, 1946. Tractor numbers in 1930, on the other hand, were only 36 percent of the high number reported on January 1, 1946 (table 17).

Thus, all three—automobiles, tractors and trucks—were responsible for increasing machinery inventories during the earlier part of the period 1910–45. But of the three, farm tractors have been responsible for most of the increase in inventories since 1930. This is noteworthy when considered along with the declining numbers of farm horses and mules. It means that all three machines were responsible for horse-and-mule displacement in the earlier part of the period, but that tractors were very largely responsible for this displacement in the latter part of the period. At present, increases in tractors on farms measure fairly well the reduced need for horses and mules on farms.

TABLE 17.—*Numbers of tractors and other specified machines on farms, United States, January 1, 1910–46*

Year	Farm tractors	Farm motortrucks	Farm automobiles	Grain combines	Corn pickers	Milking machines
	Thousands	*Thousands*	*Thousands*	*Thousands*	*Thousands*	*Thousands*
1910........	1	0	50	1	....	12
1920........	246	139	2,146	4	10	55
1930........	920	900	4,135	61	50	100
1940........	1,545	1,047	4,144	190	110	175
1941........	[1] 1,675	[1] 1,095	4,190	225	120	210
1942........	1,890	1,160	4,285	275	130	255
1943........	2,100	1,280	4,175	320	138	309
1944........	2,210	1,370	4,120	345	146	345
1945........	2,425	1,460	4,100	375	168	379
1946........	2,585	1,550	4,100	415	200	450

[1] 1941–44 data are revised estimates of Bureau of Agricultural Economics, adjusted to preliminary census numbers; 1945 numbers are from preliminary census report.

The tremendous wartime increase in numbers of tractors and tractor labor-saving machines and motortrucks explains in large measure how fewer farmers with fewer hired and family workers did a much larger production job. Not until after the findings of the 1945 agricultural census became available did anyone fully realize the extent to which manufacturers, servicemen, farmers, and others had worked together to keep farm machines in working order. It is estimated that during the war more than 250,000 farm tractors that ordinarily would have been junked were kept going in this way as were many automobiles, trucks, combines, and other machines.

Many of these will probably be junked in the near future as new machines become available. But some of them may remain on farms for several years as a second or third tractor or machine; and some may find their way to small farms where the work load is light, and where the cost of new tractors and machines seems too high for the available volume of business.

When horse and mule values, including harness, are added to machinery values the total increase in farm animal and mechanical power and farm machines is much less pronounced than is the increase when animal power is omitted. For example, the total value of all machinery and horses and mules on farms on January 1, 1910 was about 4 billion dollars compared with a peak of 7.3 billion dollars on January 1, 1945, an increase of only 80 percent compared with the increase of 400 percent when horse and mule values are omitted from the totals. This large difference is explained by the fact that the inventory value of horses and mules and harness on January 1, 1945 was only 1.1 billion dollars compared with 2.8 billions at the beginning of 1910. Peak current inventory values before World War II were recorded in the postwar year 1920, and low inventory values occurred in the depression year 1934.

If allowances are made for changes in prices of farm horses and mules and for machinery, the inventory volume of total farm power and machinery seems to have been remarkably constant during the last 25 years, with the exception of the years immediately following World War I and the years of World War II when machinery purchases were very large, and the 1930's when machinery purchases were at

a long-time low (fig. 5). During the first 8 years of the 37-year period, numbers of horses and mules, automobiles, and horse-drawn machines were increasing. This increase was continued well into the 1920's, except in the case of horses and mules, whose decline was more than offset by increasing numbers of tractors, tractor machines, and motortrucks. From 1910 to 1916, harvested crop acreages increased at an average rate of about 1 percent per year, and volume of farm machinery and power, exclusive of automobiles, at about the same rate. If automobiles are included, the average rate of increase was about 2 percent per year. After World War I large purchases of machinery, including automobiles, boosted the inventory volume of machinery and power on farms higher in relation to crop acreages than ever before. The same thing happened again in World War II period, and the upward swing in farm mechanization is still very strong.
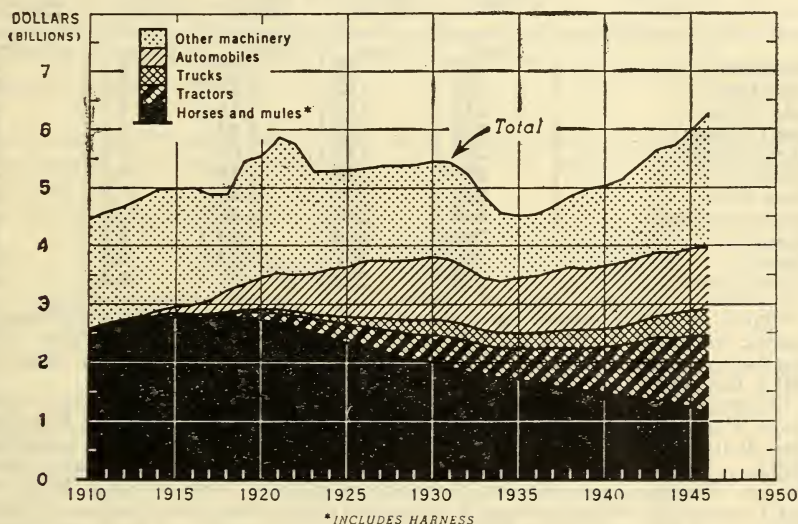
FIGURE 5—INVENTORY VALUES OF FARM HORSES AND MULES, AND FARM MACHINERY, JANUARY 1, UNITED STATES, 1910-46.
(VALUE IN 1935-39 AVERAGE DOLLARS)

When adjustments are made in the inventory values shown in figure 4 for changes in price levels, the inventory value, or volume, of all farm power, machinery, and equipment has varied remarkably little during most of the last 25 years. More automobiles, motortrucks, tractors and tractor machines, and equipment have made up for fewer horses and mules, and horse-drawn machines and equipment.

Displacement of Work Animals by Mechanical Power

During World War I and during the first half of the 1920's farm tractors were used almost exclusively for the heavier farm jobs, as plowing and disking, and for belt work. In the early days of their use a farmer who bought a tractor usually disposed of only 2 to 3 horses, and this practice was followed on the larger farms that had a good many horses. As the general-purpose type of tractor came into use, and as more and better tractor machines and equipment were made, more horses could be disposed of when a tractor was bought.

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Displacement of animal power by farm tractors has not been uniform in all parts of the country according to a survey in 1943 of 10,022 tractor- and animal-operated farms (table 18). This study showed that the number of work animals displaced per farm tractor averaged only 1.8 in the Northeastern States compared with 3.4 in the Corn Belt, 5.3 in the Great Plains wheat and range country, and 10.6 on the farms reporting in the Pacific Coast States. The average displacement for all farms reporting was 4.4 head of workstock.

TABLE 18.—*Size of farms, cropland harvested, and numbers of farm tractors and horses and mules 3 years or more of age on farms reporting tractors and work stock on January 1, 1943* [1]

State group [2]	Size of farm in 1942	Cropland harvested per farm in 1942	Tractors per farm January 1, 1943	Work animals per farm January 1, 1943	Work animals displaced per farm tractor [3]
	Acres	*Acres*	*Number*	*Number*	*Number*
Northeast.............	197	98	1.20	2.7	1.8
Corn Belt.............	237	152	1.25	3.1	3.4
Lake States...........	219	132	1.19	3.1	2.3
Great Plains..........	755	340	1.33	4.4	5.3
Appalachian..........	292	113	1.09	3.8	2.2
Southeast.............	381	143	1.18	4.1	2.1
Delta States..........	600	309	1.80	10.5	5.8
Oklahoma-Texas.......	894	294	1.31	3.8	8.6
Mountain.............	1,709	265	1.28	5.5	7.3
Pacific...............	920	297	1.43	3.8	10.6
United States..........	522	202	1.27	3.8	4.4

[1] Based on 10,022 reports for tractor farms having work animals, distributed as follows: Northeast, 1,120; Corn Belt, 2,676; Lake States, 1,441; Great Plains, 1,752; Appalachian, 379; Southeast, 528; Delta, 214; Oklahoma-Texas, 542; Mountain States, 698; and Pacific, 672.

[2] Northeast includes Maine, New Hampshire, Vermont, Massachusetts, Rhode Island, Connecticut, New York, New Jersey, Pennsylvania, Delaware, and Maryland. Corn Belt includes Ohio, Indiana, Illinois, Iowa, and Missouri. Lake States include Michigan, Wisconsin, and Minnesota. Great Plains include North Dakota, South Dakota, Nebraska, and Kansas. Appalachian includes West Virginia, Kentucky, and Tennessee. Southeast includes Virginia, North Carolina, South Carolina, Georgia, Florida, and Alabama. Delta includes Mississippi, Arkansas, and Louisiana. Mountain includes Montana, Idaho, Wyoming, Colorado, Utah, Nevada, New Mexico, and Arizona. Pacific includes Washington, Oregon, and California.

[3] It was assumed that if there were no tractors the number of work stock needed in each State group would be the same per 100 acres of cropland as was reported for horse or mule farms. From the calculated number of needed work animals on tractor farms, the actual number of work stock on tractor farms was deducted and this figure divided by the average number of tractors gives the work animals displaced per tractor.

The average size of all tractors on farms in 1942 probably was around 15- or 16-drawbar horsepower (rated load basis). The average tractor of 15 or 16 horsepower therefore displaced only 4.4 horses and mules of work age. It is evident that tractors have a large surplus of power. Probably few farm jobs use this surplus. Consequently, it is not surprising that, at a given time, the inventory value of the average farm tractor is more nearly in proportion to the average value of the workstock displaced than to the drawbar power displaced, especially after farms became well supplied with automobiles and trucks. The 1935-39 average inventory value of tractors on farms was about $500 and the

average value of the estimated 4.4 head of work animals displaced by a tractor in 1942 was about $450.

This apparent per tractor displacement of work animals on farms that have tractors does not represent the long-time disappearance of work horses and mules from farms as tractor numbers increased. For example, from 1919 to 1924 tractors on farms increased by 338 thousand but horses and mules of work age decreased by only 10 thousand. This is a decrease of only 0.03 of a work animal for each tractor added to farm inventories during the 5 years (table 19). In this postwar period of farm mechanization there were several million head of colts and young work animals on farms that had been produced because of prewar city and farm demand, and because of wartime civilian and military needs. Large colt crops previous to and during this postwar period resulted in a decline of only 10 thousand animals of work age whereas the number of horses and mules decreased by more than 3 million head. For many years during this transition period, when mechanical power was increasing rapidly, farms as a whole were apparently over-equipped with motive-power units.

TABLE 19.—*Disappearance of horses and mules from farms, and increase in farm tractors and automobiles and trucks, by periods, United States, 1919–44*

Period of change	Increase in tractor numbers on farms	Decrease in number of horses and mules on farms		Disappearance from farms of horses and mules, per tractor		Increase in numbers of all auto-mobiles and motor trucks on farms
		Animals of all ages	Animals 3 years old and older	Animals of all ages	Animals 3 years old and older	
	Thousands	*Thousands*	*Thousands*	*Number*	*Number*	*Thousands*
Change from January 1:						
1919 to 1924.........	338	3,205	10	9.48	0.03	1,496
1924 to 1929.........	331	3,541	2,610	10.70	7.89	1,443
1929 to 1934.........	189	2,747	2,275	14.53	12.04	[1] 536
1934 to 1939.........	429	2,205	3,035	5.14	7.07	776
1939 to 1944 [2].......	765	2,179	1,496	2.85	1.96	440
1919 to 1939.........	1,287	11,698	7,930	9.09	6.16	3,179
1919 to 1944.........	2,052	13,877	9,426	6.76	4.59	3,619

[1] A decrease.
[2] 1939–44 computations made from revised estimates of Bureau of Agricultural Economics.

During the next 5 years 1924–29, tractor numbers increased about the same as during 1919–24 but workstock numbers decreased by 2.6 million head. The decrease in workstock numbers for each tractor added to farm inventories during this 5-year period was about 7.9. In the following 5-year depression period, 1929–34, workstock continued to decrease rapidly but tractors increased rather slowly. More than 12 head of workstock disappeared from farms for each tractor added.

During the war years, 1939–44, the increase in tractors was almost 80 percent greater than in the previous 5 years. Even though numbers of workstock decreased by about 1.5 million head, therefore, tractor numbers increased so much more rapidly that workstock displacement amounted to only about 2 head per tractor added to farm numbers

during these war years. Although these comparisons are in terms of average disappearance per tractor, it must be remembered that increasing numbers of automobiles and trucks helped to effect this displacement, especially in the earlier years (table 19).

Figure 6 shows the rapid increase that has taken place in the number of tractors on farms, and the decrease in number of farm horses and mules, since World War I. The first large increase in tractor numbers came after the war's end, when agricultural and industrial production for peacetime consumption were at high levels. Development of the general-purpose type of tractor, and its widespread adoption by farmers in the late 1920's was chiefly responsible for maintenance of the rapid upward trend in the number of tractors on farms. In the late 1930's rubber-tired general-purpose tractors came on the markets. These were bought freely by farmers, and the increase in tractor numbers, which had slowed down during the depression years, was resumed. The present large postwar demand for farm tractors and tractor equipment points to a continuation of the strong upward swing in farm mechanization. Horses and mules of work age will continue to disappear, unless the downward trend in colt production is halted.
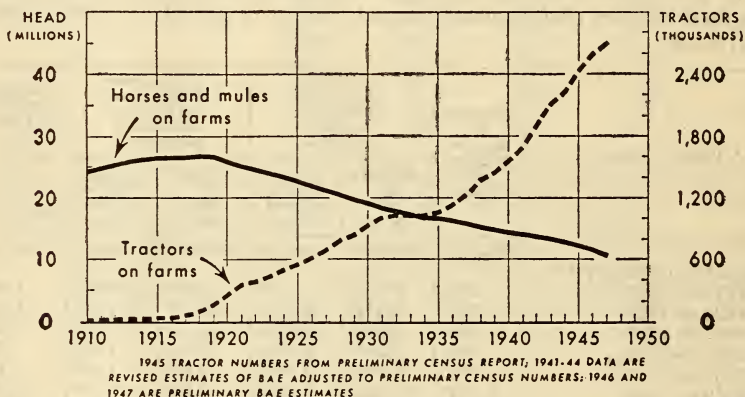
FIGURE 6—HORSES AND MULES, AND TRACTORS ON FARMS, JANUARY 1, UNITED STATES, 1910-47.

Horses and mules, including colts, reached peak numbers in 1918, and have declined since. Colts are now insufficient to maintain the numbers of horses and mules of working age. Tractors had become basic equipment on many farms by 1930, and were added rapidly thereafter as farmers were able to buy a tractor and tractor equipment.

Tractors and Tractor Equipment

The starting place in saving crop labor by mechanization is the farm tractor. By itself, it saves no labor—it is merely the power unit for machines and tools that, combined with more power and a higher rate of travel, do farm jobs faster. Two important machines that have been developed along with tractors are grain combines and mechanical corn pickers. In 1910 there were 1,000 farm tractors and 1,000 grain combines. Most of the latter were being operated with horses and mules. In 1946, there were about 2.6 million farm tractors

and 415,000 combines, practically all of which were operated with tractors. Mechanical corn pickers increased from 10,000 in 1920 to 200,000 in 1946. Milking machines helped to save labor in the dairy barns. In 1946, there were 450,000 milking-machine installations compared with only 12,000 installations in 1910 (table 17).

Similar data for several other tractor- and horse-operated machines are available for each year during 1942–45. There were more of most tractor-operated machines and fewer of each horse-operated machine on farms in 1945 than in 1942 (table 20). Windrow pick-up balers increased by 67 percent. Peanut pickers, corn pickers, grain combines, and tractor-operated cultivators, mowing machines, and row-crop planters increased by about 25 percent on the average. Tractor-operated plows, listers, and middlebusters of all kinds and sizes increased 10 percent from January 1, 1942 to January 1, 1945. On the other hand, the general rule was for horse-operated machines and tools to decrease in numbers by about 5 to 10 percent, and horse-operated stationary hay balers decreased by 12 percent.

TABLE 20.—*Estimated number of specified machines and implements on farms on January 1, 1942 and 1945, United States totals* [1]

Machine or implement	1942	1945	Percentage 1945 is of 1942
	Thousands	*Thousands*	*Percent*
Manure spreaders—mostly horse-drawn........	1,159.7	1,128.5	97
Moldboard plows—tractor-drawn.............	1,468.4	1,616.4	110
Moldboard plows—horse-drawn..............	7,670.8	7,239.6	94
Disk plows—tractor-drawn....................	167.2	176.3	110
Disk plows—horse-drawn...................	83.1	73.9	89
One-way disk plows or tillers—tractor-drawn....	160.9	168.5	105
Listers and middlebusters— tractor-drawn......	292.2	313.1	107
Listers and middlebusters—horse-drawn........	1,277.3	1,217.0	95
Disk harrows—tractor-drawn.................	1,189.7	1,262.6	106
Disk harrows—horse-drawn..................	1,337.3	1,244.6	93
Row-crop planters—tractor-drawn.............	205.2	255.6	124
Row-crop planters—horse-drawn..............	3,419.8	3,238.1	95
Row-crop cultivators—tractor-drawn..........	889.3	1,171.2	131
Row-crop cultivators—horse-drawn............	7,072.4	6,764.0	96
Grain drills—tractor-drawn...................	428.4	420.6	98
Grain drills—horse-drawn....................	1,277.9	1,220.8	96
Grain binders—tractor-drawn.................	365.6	337.1	92
Grain binders—horse-drawn..................	1,015.8	909.3	91
Grain combines—tractor-drawn...............	275.0	375.0	136
Grain separators—threshers..................	167.9	152.8	91
Mowing machines—tractor-drawn or mounted...	313.7	395.2	126
Mowing machines—horse-drawn..............	2,571.1	2,423.5	94
Rakes, sulky or dump.......................	2,164.6	2,084.3	93
Rakes, side delivery.........................	715.6	739.1	103
Balers, windrow pick-up—tractor-drawn........	25.1	41.9	167
Balers, stationary—power-operated............	66.2	65.3	99
Balers, stationary—horse-operated............	61.6	54.0	88
Row-binders—tractor-drawn..................	82.3	86.4	105
Row-binders—horse-drawn...................	526.8	491.8	93
Corn pickers—tractor-drawn.................	130.0	168.1	129
Peanut pickers..............................	8.5	11.2	132
Cream separators...........................	1,750.5	1,751.0	100
Milking machines...........................	254.7	379.3	149

[1] Brodell, A. P., and Cooper, M. R., Number and Duty of Principal Farm Machines, Bureau of Agricultural Economics, F.M. 46, Nov. 1944. (Processed.)

At the beginning of 1942 farmers had more than 11 million plows, listers, and middlebusters, of all kinds and sizes, or an average of about 2 per farm. By January 1945 the total had decreased by about 315 thousand, but the decrease was in the less effective horse-drawn plows and listers, and there were more tractor-drawn plows and listers. The change undoubtedly meant an increase in plow and lister capacity from 1942 to 1945. Total numbers of other machines, like row-crop planters and cultivators, and mowing machines, decreased from 1942 to 1945, but those operated with tractor power increased so that here again the work capacity of the equipment was increased.

Numbers of both horse-drawn and tractor-drawn grain binders decreased during 1942–45. But these were being replaced by increasing numbers of a newer and more efficient type of machine—the combine harvester-thresher. Numbers of stationary grain separators decreased also. Mechanical corn pickers increased during the period by almost 30 percent. These additional machines probably now pick 250 to 275 million bushels of corn that were picked by hand in 1942. Pick-up hay balers probably now bale more than double the quantity of hay and straw that was baled in this way in 1942.

Farmers of the United States, in general, own most of their farm machines and tools, especially the smaller and less expensive ones, such as plows, cultivators, and planters. Machines like tractors, trucks, hay balers, corn pickers, and grain threshers are expensive for many farmers. They are more suitable for joint ownership by small producers and for outside custom and exchange work. During World War II there was a decided increase in the consolidation of farms in some areas. Some of these were partnership consolidations of two or more units owned by close relatives. These consolidations included the farm machines and livestock as well as the land. In some instances of this nature the size of the farm was increased to take advantage of available machinery and labor, but the number of farm families deriving income from the farms remained the same.

Present inventories of farm machines include machines on many farms that are not fully used. Timeliness of use of some machines is so important that the farmer prefers to own the machine even though its annual use is very restricted. Some of the machines and tools in farm inventories are large horse-drawn machines for which there is no great use in the locality. Then, there are modern machines for which there is only limited outside work.

The milking machine, ordinarily used twice during nearly every day in the year, was used more in 1941 than any other of the machines listed in table 21, or an average of 684 hours per year. Farm tractors were used an average of about 500 hours per year, and cream separators about 140 hours. Planters, binders, mowing machines, and drills were usually used well under 100 hours per year.

Undoubtedly, the general tendency during the war was to increase the average annual use of labor-saving machines. The range in use of machines on individual farms is very wide. Some of the smaller and less expensive tools are sometimes used no more than a full day each year—but they may be very essential at just the right time. Tractor-drawn equipment generally is used on larger farms than horse-drawn machines, and is used more hours and does more work per year than

horse-drawn equipment. For example, 2-row tractor-drawn row-crop planters were used to plant an average of 131 acres in 1941, but 2-row, horse-drawn planters averaged only 46 acres. Tractor-drawn or mounted mowing machines of all sizes cut an average of 154 acres in 1941, compared with an average of 54 acres per horse-drawn mower of all sizes.

TABLE 21.—*Extent of use and work done in 1941 for indicated kinds, and sizes of machines* [1]

Kind of machine	Size of machine and power used	Time machine was used in 1941		Average amount of work done with machine in 1941
		Usual range	Average	
		Hours	*Hours*	*Acres*
Row-crop planters.	2-row, tractor-drawn.......	20–250	76	131
	4-row, tractor-drawn.......	20–250	80	262
	2-row, or more, horse-drawn.	10–250	40	46
	1-horse..................	5–300	50	28
Row-crop binders..	1-row, tractor-drawn.......	10–250	51	38
	2-row, tractor-drawn.......	20–350	91	130
	Various sizes, horse-drawn..	10–250	34	20
Mowing machines..	Various sizes, tractor-drawn or mounted............	20–500	78	154
	Various sizes, horse-drawn..	10–400	63	54
Grain drills.......	Various sizes, tractor-drawn.	20–500	79	201
	Various sizes, horse-drawn..	10–350	44	44
Grain binders.....	Various sizes, tractor-drawn.	20–350	55	100
	Various sizes, horse-drawn..	10–225	34	37
Grain combines....	6 feet and less, tractor-drawn.................	25–400	110	126
	Over 6 feet and under 10, tractor-drawn..........	25–400	126	207
	10 feet and over, tractor-drawn.................	25–400	143	400
				Tons
Manure spreader..	Various sizes, horse- and tractor-drawn..........	25–1,000	142	177
Farm tractors [2]....	Various sizes and types.....	100–1,400	493	....
Milking machines..	Various sizes...............	200–2,000	684	....
Cream separators..	Various sizes	50–800	139	....

[1] Brodell, A. P., and Birkhead, James W., Work Performed With Principal Farm Machines. Bureau of Agricultural Economics, F.M. 42, May, 1943. (Processed.)
[2] Brodell, A. P., and Cooper, M. R., Fuel Consumed and Work Performed by Farm Tractors. Bureau of Agricultural Economics, F.M. 32, March, 1942. (Processed.)

Not only are tractor-drawn machines used more hours per year than are horse-drawn machines, but principally because of larger machines and higher rates of travel, they do much more work per hour. Table 22 gives several examples of an average day's work with different sizes of machines, operated with specified units of animal or tractor power. These illustrate a compelling influence in the change in pattern of farm power and machines over the last 20 to 30 years. One man with a 2-bottom, 14-inch moldboard plow drawn by 5 horses will plow 4 acres in a 10-hour day, but with a tractor plow of the same size and a 15-horsepower tractor he will plow 8 acres in the same time—and if necessary he can keep going for 12, 14, or more hours per day, whereas the horses after 10 hours in the field must rest until the next day.

TABLE 22.—*Daily duty of machines of specified kinds and sizes*

Operation	Kind and size of implement [1]	Power used [2]	Average acres covered per 10-hour day
Plowing.......	Moldboard, walking, 8-inch.......	1 horse........	1.0
	Moldboard, walking, 14-inch......	2 horses......	2.0
	Moldboard, 2-bottom, 14-inch.....	5 horses......	4.0
	Moldboard, 2-bottom, 14-inch.....	15-h.p. tractor.	8.0
	Disk plow, 50-inch..............	20-h.p. tractor.	13.0
	Disk plow, 10-foot, vertical, one way.......................	20-h.p. tractor.	28.0
Disking.......	Single disk, 8-foot, once over......	4 horses......	15.0
	Single disk, 20-foot, once over.....	20-h.p. tractor.	60.0
Harrowing.....	Spike-tooth, 10-foot, once over.....	2 horses......	15.0
	Spike-tooth, 20-foot, once over.....	4 horses......	30.0
	Spike-tooth, 24-foot, once over.....	15-h.p. tractor.	70.0
	Spike-tooth, 32-foot, once over.....	20-h.p. tractor.	90.0
Cultivating....	½-row, walking (2 times to row)...	1 horse.......	2.5
Corn or	1-row, riding (1 time to row)......	2 horses......	7.0
cotton......	2-row, riding (1 time to 2 rows)....	3 horses......	12.0
	2-row, riding (1 time to 2 rows)....	15-h.p. tractor.	20.0
	4-row, riding (1 time to 4 rows)....	15-h.p. tractor.	35.0
Cutting corn...	Binder, 1-row (corn not shocked)...	3 horses......	6.5
	By hand (corn shocked)..........	Hand......	1.2
Picking corn...	Mechanical picker, 1-row..........	15-h.p. tractor.	7.0
	Mechanical picker, 2-row..........	20-h.p. tractor.	12.0
	By hand...................	Hand......	1.5
Mowing hay...	Mower, 5-foot...................	2 horses......	8.0
	Mower, 7-foot...................	15-h.p. tractor.	20.0
Drilling grain..	Disk drill, 7-foot................	3 horses......	12.0
	Disk drill, 10-foot...............	6 horses	18.0
	Disk drill, 10-foot...............	20-h.p. tractor.	25.0
	Disk drill, 20-foot...............	20-h.p. tractor.	50.0
Harvesting....	Binder, 6-foot..................	3 horses......	9.0
grain........	Binder, 8-foot:.................	4 horses......	14.0
	Binder, 8-foot..................	15-h.p. tractor.	20.0
	Combine, 5-foot................	15-h.p. tractor.	11.0
	Combine, 10-foot...............	20-h.p. tractor.	22.0
	Combine, 16-foot...............	20-h.p. tractor.	30.0
Milking cows [3].	Milking machines, 2 unit (one milking).......................	Electric motor.	[4] 3-5
	Milking by hand (one milking)....	Hand........	[4] 8-10

[1] Size represents working width.
[2] For modern tractors equipped with rubber tires.
[3] Minutes per cow include time for caring for machine and milking utensils.
[4] Minutes per cow.

For obvious reasons these larger, faster, and more expensive power and power-operated machines were first used almost exclusively on the larger farms. Gradually, machines were manufactured more and more in line with the needs of farmers who had commercial family-sized farms and, to some extent, to the needs of less than full-time farmers. On large farms in the Great Plains one man with a 10-foot one-way plow and a modern 20-horsepower tractor will plow an average of 28 acres in a day, which is more land than many farmers on small farms will have available for plowing in an entire season. A 10-foot spike-tooth harrow drawn by 2 horses will cover, once over, about 15 acres in a day. A few days of work a year with this size of harrow will do all the harrowing there is to be done on many small farms. But the large operator with 1,500 or 2,000 acres of semi-arid cropland must

do the bigger job with bigger equipment. With a 32-foot spike-tooth harrow and a 20-horsepower modern tractor he will harrow 90 acres in a day—a full week of work with the smaller horse-drawn harrow.

Generally, large machines are associated with large acreages, large fields, and extensive types of farming, and small machines with small acreages, small fields, rough lands, and some of the more intensive types of agriculture. The size of the job to be done and the conditions under which the work is to be done help to determine the selections to be made from the various kinds and sizes of machines. Our farmers have a wide choice in kinds and sizes of farm machines and tools, and may make their selections according to the needs of their particular situations. Thus, changes in the pattern of farm mechanization in the different localities and regions may be influenced more often by type of farming and available physical and financial resources than by other factors.

Effect on Timeliness of Operation

No precise measure is available of the effect of mechanization on production because of timeliness in doing farm operations. Yet much evidence points to greater production and higher quality of product because of better timing of operations, made possible mainly by up-to-date power units and machines. Trading centers now in many cases are several hours closer to the farm than in days of poor roads and slow teams. A broken part for the hay loader may be brought from town and installed and the haying operation resumed in a few hours, whereas formerly the storing of hay under cover might be postponed until the next day. And a modern machine shop on the farm might reduce the lost time considerably, especially in the latter case. More acres per hour with modern power machines—and more hours per day when necessary—help to get the critical jobs done right and on time. Facilities for better and more timely grading, cooling, and storing, insure better products in the markets.

But the real advantages often come in seasons of adverse working conditions. These are the critical times when the difference in equipment and power means the difference between little or no crop and a large crop.

This is how one farmer illustrated the point. In a dry, hot fall he bought a tractor and equipment because he could not plow the hard ground in time for seeding wheat with the power he had available. He prepared the ground and seeded 85 acres of wheat with the new outfit, compared with a possible 10 or 15 acres he could have done with the old horse-drawn tools. He said that the difference in costs between animal and tractor power was unimportant under the circumstances—he had more than 2,000 bushels of wheat to sell the following July instead of a possible 2 or 3 hundred bushels, and his farming scheme was not interrupted. Size of business was important in the case cited. Small farmers may not be able to switch so readily when the purchase of a tractor and equipment is involved, but probably many can meet such emergencies by hiring the work done by custom operators.

An excellent illustration of the contribution of mechanical power to timeliness of operations is the experience of Corn Belt farmers in the

very wet spring seasons of 1943, 1944, and 1945. In the corn-planting month of May 1943, for example, rainfall in Illinois was 8.75 inches, or more than double the usual precipitation. The fields were so wet that only 15 percent of the corn crop was planted by June 1, which is generally about the outside date for planting in the State. By utilizing all available mechanical power and equipment the corn lands were prepared, and the remaining 85 percent of the crop was planted in the first 2 weeks after the rains stopped and the land became workable. Some of the machines came from off-farm places, and many of them were operated on a 24-hour schedule. As the season advanced, earlier maturing strains of seed were brought in from farther north, and by June 15 the basic job had been completed. The corn crop that year was the largest Illinois had ever had.

If tractor power had not been available large acreages of corn could not have been planted in time to get a crop. Other large acreages would have been in poor condition, and many late plantings would have produced little solid corn. The speeding up of work in Illinois with power equipment was brought about in two ways—by working more continuous hours and by doing more work per hour. With a tractor and the tractor equipment commonly used in Illinois, 3 acres can be prepared and planted to corn in the same time required to prepare and plant 1 acre with animal power and equipment. When the tractor is put on a 24-hour schedule (an impossibility with work animals) 7 acres can be prepared and planted as compared with 1 acre with animal power.

The example of the tractor's accomplishment in Illinois probably could be duplicated on a smaller scale somewhere in any season. The cumulative effect of the numerous cases of "late seasons" on production must be very large in some years. It is entirely possible that the great amount of work that can be done in a short time with mechanical farm equipment has largely eliminated low production caused by the narrowing of planting seasons by rains and storms. It is possible also that weather hazards in the cultivating and harvesting seasons are not so great as when the work was done by time-consuming methods. The working facilities, provided by tractor farming, combined with the greater range in the number of days required to mature crops from various strains and varieties of seeds, and a more widespread knowledge of crop responses to various applications of fertilizer, have brought about a higher average yield of our major crops than previously was possible. This does not mean, however, that all of the fluctuations in yields and production have been eliminated. Damage to growing crops because of droughts, storms, freezes, diseases, insects, etc. cannot be completely eliminated.

Regional Changes in Mechanization

Beginning on page 12 the idea was developed that high production per worker is generally found in those areas in which soils are productive and the topography and type of agriculture are suitable for labor-saving machines. It is in these areas that changes in mechanization have been most pronounced. These changes are fairly well indicated by changes in tractor numbers since 1920 (fig. 7). In 1920, tractors were most common on the grain and livestock farms of the Great Plains and Corn Belt. Local areas in California and the Pacific

Northwest were relatively well supplied with farm tractors. Heavy concentration of farm tractors are now found in the Corn Belt, the wheat areas, the fertile fruit and crop areas in the East and in the irrigated valleys of the West. A large proportion of the tractors on Southern farms are in the concentrated rice, sugarcane, and tree fruit and nut areas and in some cotton areas.
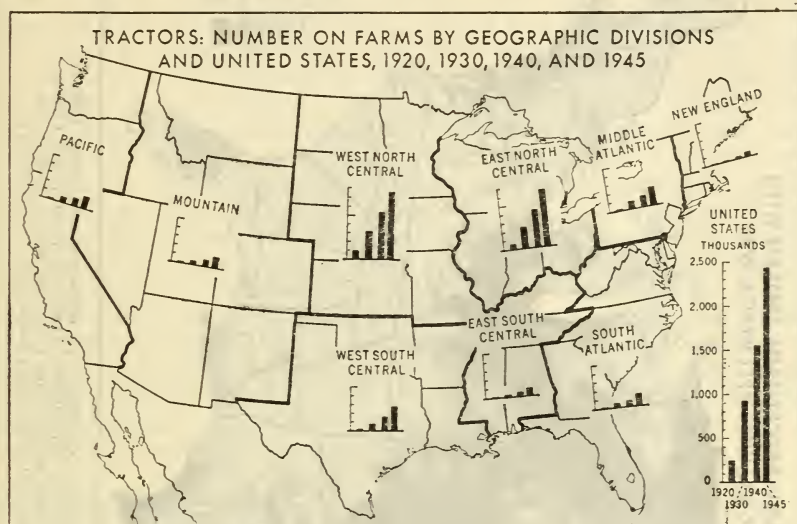
FIGURE 7—INCREASE IN TRACTOR NUMBERS HAS BEEN GREATEST ON FARMS IN THE CENTRAL AND SOUTHWESTERN PARTS OF THE UNITED STATES. SOUTH-EASTERN FARMS REMAIN RELATIVELY UNDER-MECHANIZED.

The pattern of tractor distribution coincides closely with the pattern of volume of work in land preparation and cultivation per worker. More than 325,000,000 acres in the United States are seeded to crops each year, and most of this land is broken before being seeded (plowed, listed, or bedded). In 1939 about 55 percent of this breaking was done with tractor power, and the practice has increased decidedly since then. Disking and harrowing also require considerable power. Frequently, the optimum seasons for preparing land are short. In 1939 about 57 percent of the disking and 43 percent of the harrowing was done with tractor-drawn implements. The regional pattern for tractor disking and harrowing follows closely the regional pattern for land breaking with tractor power.

In 1939, 70 percent or more of large areas in the Corn Belt and in the western half of the United States were broken with tractor power (fig. 8). In many other important farming areas in the western half of the country and in the northern part of the eastern half of the country, tractor power was used for doing 50 to 70 percent of the land breaking. In large areas of the South, where many fields are small and many workers are needed for chopping and picking cotton, a small percentage of the land breaking was done with tractor power in 1939. In large southern areas as much as 90 percent of the breaking was done with animal power.

BREAKING LAND: PERCENTAGE BROKEN WITH TRACTOR-DRAWN IMPLEMENTS, 1939

PERCENT
Under 10.0
10.0 - 29.9
30.0 - 49.9
50.0 - 69.9
70.0 and over
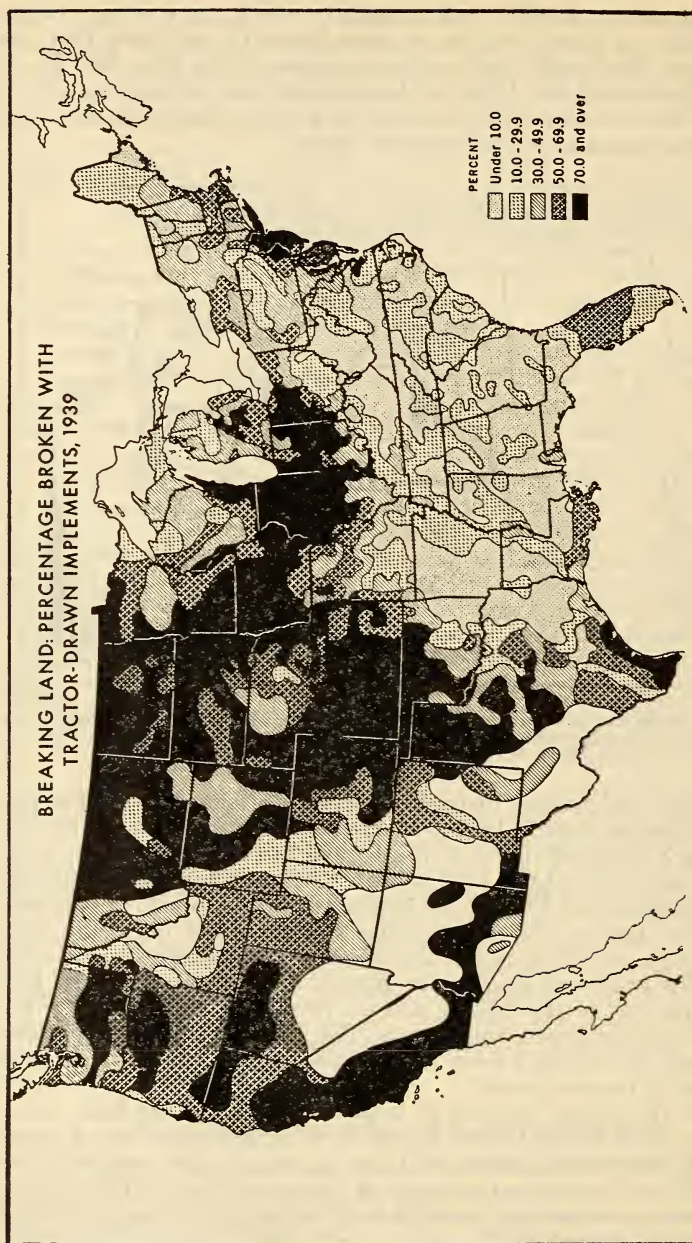
FIGURE 8—MOST OF THE LAND SEEDED TO CROPS IS BROKEN (PLOWED, LISTED, OR BEDDED) ONE OR MORE TIMES BEFORE BEING SEEDED. TRACTORS FURNISH THE BULK OF THE POWER FOR BREAKING LAND IN MOST AREAS OF THE WESTERN HALF OF THE COUNTRY AND CENTRAL CORN BELT.

There is at present a large and growing unfilled demand in extensive areas of the South for farm tractors and tractor tools. A few mechanical cotton pickers are being used and plans call for the manufacture of cotton pickers in considerable volume. Many informed persons believe

that mechanization of the cotton harvest will be a long, drawn-out process. However, because of increased cotton yields per acre more of the South's cropland is now being used for grain and forage, both of which are suitable for mechanization.

In the northeastern part of the United States farmers had more tractors per 100 acres of cropland in 1945 than was true in any other geographic division, including the rich, level north central divisions. Farmers in the East South Central States had the fewest tractors per 100 acres of cropland. The range from high to low, by geographic divisions, was 1.46 tractors per 100 acres of cropland in the New England States to only 0.34 of a tractor in the East South Central division (table 23). These differences do not necessarily indicate differences in extent of optimum mechanization in the divisions at a given time. Greater tractorization of Southern farms has had to wait until progress was made in other lines of mechanization. The relatively large number of tractors per 100 acres of cropland in the East does not necessarily mean waste of tractor power. The nature of the topography and the variety of crops mean more hours per acre of crops than are required in midwestern areas, whether the work is done with tractor or with animal power. The hours saved by using a tractor on crops in the East are especially valuable in caring for livestock on many poultry and dairy farms, even though the acreages are not large. Feed grinding, silo filling, and manure hauling are suitable for tractor use, but are not very important on noncommercial livestock farms.

TABLE 23.—*Number of tractors per 100 acres of total cropland,[1] by geographic divisions, 1920, 1930 and for the years 1940–45*

Geographic division	1920	1930	1940	1941	1942	1943	1944	1945
New England........	0.05	0.36	0.76	0.88	0.97	1.15	1.28	1.46
Middle Atlantic.....	.08	.56	.91	.99	1.07	1.23	1.35	1.42
East North Central..	.09	.43	.77	.82	.92	.99	1.01	1.07
West North Central.	.07	.22	.40	.42	.48	.52	.51	.55
South Atlantic......	.03	.17	.21	.25	.28	.35	.39	.48
East South Central..	.02	.09	.15	.18	.20	.25	.27	.34
West South Central..	.04	.12	.29	.31	.37	.42	.44	.49
Mountain..........	.08	.17	.28	.31	.34	.38	.38	.42
Pacific.............	.11	.34	.49	.53	.57	.62	.66	.71
United States.	.06	.24	.42	.46	.52	.57	.59	.64

[1] Includes acreages from which one or more crops were harvested, and acreages of crop failure and summer fallow.

Eastern farmers with their smaller acreages of cropland, have relatively high investments in farm machinery and power. In 1945 the total value of machinery and power (in terms of 1935–39 average dollars) was more than $38 per acre of cropland in the New England and Middle Atlantic States, compared with less than $12 per acre in the West North Central States (table 24). Even with the high proportion of relatively low-priced 1- and 2-mule tools in the South Atlantic and East South Central States, values of machinery and power were about $19 and $17 per acre of cropland, respectively. In only 1 of the 9 geographic divisions were values per acre, at 1935–39 prices, less in 1945 than in 1910. In 2 divisions total value of machinery and power

TABLE 24.—*Value of horses and mules, tractors, motortrucks, automobiles, and other farm machinery, per acre of cropland, by geographic divisions, 1910, 1920, 1930, 1940–45*

[Values at 1935–39 average prices]

Geographic division	1910	1920	1930	1940	1941	1942	1943	1944	1945
	Dollars	Dollars	Dollars	Dollars	Dollars	Dollars	Dollars	Dollars	Dollars
New England	27.90	27.64	33.11	29.27	30.00	31.25	33.49	34.02	38.75
Middle Atlantic	24.16	26.24	33.16	30.70	31.63	33.31	36.00	34.47	38.30
East North Central	14.49	16.75	16.90	18.99	19.20	19.84	20.42	20.22	20.62
West North Central	10.11	12.00	11.35	10.09	10.39	10.96	11.01	11.21	11.80
South Atlantic	14.05	17.08	16.08	15.60	16.20	16.42	16.58	17.21	18.72
East South Central	13.38	15.61	14.68	14.55	14.85	15.04	15.14	15.90	16.77
West South Central	11.52	11.12	10.77	10.13	10.52	11.23	11.63	11.68	13.10
Mountain	15.10	12.88	11.71	10.56	10.44	11.03	11.30	11.61	12.80
Pacific	12.22	16.02	16.51	16.64	17.51	17.97	18.82	18.89	20.55
United States	13.04	14.52	13.99	13.56	13.92	14.54	15.18	15.05	16.10

per acre, at 1935–39 prices, was slightly less in 1945 than in 1920, and change in the composition was noticeable in all divisions (see table 44 in the appendix).

The general pattern of change in the component parts of machinery and power per acre of cropland has been the same in each geographic division. Less investment in horses and mules, and more investment in tractors, trucks, and automobiles has been the general tendency. The rate of change, however, has been different in the different divisions. The relative importance per acre of horse and mule power (in terms of 1935–39 values) has declined less rapidly in the South Atlantic and East South Central Divisions than in other divisions, and the importance of tractors, trucks, automobiles, and other farm machinery has increased less rapidly than in most divisions. In 1945, for example, the 1935–39 dollar values of horses and mules per acre in the South Atlantic and East South Central States was only 30 percent less than in 1920; whereas in the other geographic divisions comparable decreases between 1920 and 1945 ranged from 44 to 69 percent (table 25).

TABLE 25.—*Change from 1920 to 1945 in the value at 1935–39 average prices of horses and mules, farm machinery, and total power and machinery, per acre of cropland, by geographic divisions*

Geographic division	Decrease from 1920 to 1945 in number of farm horses and mules, per acre	Increase from 1920 to 1945 in volume of farm machinery, including tractors, trucks, automobiles, and other machinery, per acre	Change from 1920 to 1945 in volume of all farm power and machinery, per acre
	Percent	*Percent*	*Percent*
New England................	54	103	40
Middle Atlantic.............	44	101	46
East North Central.........	60	92	23
West North Central.........	62	47	−2
South Atlantic..............	30	66	10
East South Central.........	30	77	7
West South Central.........	50	110	18
Mountain..................	64	60	−1
Pacific....................	69	85	28
United States........	54	71	11

For the United States as a whole, the 25-year increase in the 1935–39 dollar values per acre of machinery and motor vehicles more than offset the decrease in value per acre of horses and mules. Increases in farm machinery and power per acre were especially large during World War II when farmers bought so' many farm tractors, motor trucks, and other labor-saving machines.

There are several reasons for the differences in value of machinery and power per acre of cropland. Some of these have been indicated. Within the same geographic region, the type and the size of farm business undoubtedly are influential factors. Farmers who have small businesses and low incomes cannot afford to buy expensive machines. Even the cheaper machines and tools may run the total investment per acre rather high if the crop acreage is small. This is not necessarily undesirable if the value per acre of farm products is large. Farmers

who have larger acreages and low returns per acre may have difficulty in paying for their machinery even though the investment per acre is relatively low.

In 1939 about 40 percent of the total value of farm products was produced on farms having horses or mules but no tractors, 50 percent on farms having tractors alone or in combination with horses and mules, and 10 percent on farms having no horses or mules or tractors (table 26). Equipping a farm with power and machinery is an important problem for the individual farmer. But many farms are so small that, purely from the standpoint of efficient national food production, it makes little difference how well or how poorly they are equipped. In 1939, for example, each of 1,145,000 farms produced less than $250 worth of farm products, including the value of commodities consumed in the farm homes. These farms represented around 19 percent of the 6 million farms in the United States, but they produced only 2 percent of the value of all farm products. Farms in the next size-group shown in table 26 were low-producing farms also. It contained more than 1,692,000 farms that produced products valued at between $250 and $599 per farm. Thus, in 1939 there were more than 2,837,000 farms that produced less than $600 worth per farm. These 2.8 million farms made up almost one-half of the total number of farms in the United States, but they contributed only 11 percent of the total value of farm production.

TABLE 26.—*Farms reporting products valued at various amounts in 1939, and percentage of United States total value of products produced on farms with indicated types of power* [1]

Value of product group	Farms reporting value of products			Percentage of total U. S. products produced on farms reporting—				
	Farms	Percentage of all farms	Percentage of farms having tractors	Work animals but no tractors	Tractors and work animals	Tractors only	No tractors or work stock	All farms in value group
Dollars	*Number*	*Percent*	*Percent*	*Percent*	*Percent*	*Percent*	*Percent*	*Percent*
Under 250	1,145,005	19.2	4.7	0.9	([2])	0.1	1.0	2.0
250 to 599	1,692,245	28.4	7.7	5.8	0.5	0.2	2.4	8.9
600 to 999	1,053,575	17.6	16.4	7.1	1.3	0.5	1.6	10.5
1,000 to 1,999 . . .	1,124,998	18.8	36.7	11.0	6.5	1.2	1.6	20.3
2,000 to 3,999 . . .	639,993	10.7	61.3	7.4	12.4	1.6	1.1	22.5
4,000 to 9,999 . . .	254,626	4.3	75.7	3.5	12.4	1.8	1.0	18.7
10,000 and over..	58,313	1.0	72.8	3.3	9.9	2.5	1.4	17.1
All groups.	5,968,755	100.0	23.4	39.0	43.0	7.9	10.1	100.0

[1] Adapted from technical monograph, Analysis of Special Farm Characteristics for Farms Classified by Total Value of Products, United States Department of Commerce and United States Department of Agriculture, 1943. Value of product is for 1939 and numbers of farms, tractors, horses, and mules for April 1, 1940.
[2] Less than 1/10 of 1 percent.

Many of these low-producing farms are part-time or self-sufficing places, and economical production often is a matter of finding ways of increasing production rather than of using more labor-saving machines. For example, about three-fourths of the farms reporting products valued at less than $250 per farm were classified as subsistence farms,

or farms on which the major source of income was from products used by the farm household. In the next group, composed of farms reporting products valued at $250 to $599, about one-half were classified as subsistence farms.

In the lowest value group (under $250) less than 5 farmers in each 100 reported having tractors in 1940, and about 53 in each hundred reported having no tractors, horses, or mules (table 27). The next size group, composed of farms producing farm products valued at $250 to $599, reported more tractor and animal power, but even in this group less than 8 farmers in each 100 owned tractors, and almost 30 percent reported no tractors, horses, or mules.

TABLE 27.—*Percentage of farms reporting tractors, work animals but no tractors, and no tractors or work animals, United States, April 1, 1940* [1]

Value of product group	Percentage of farms having tractors	Percentage of farms having work animals but no tractors	Percentage of farms having no tractors or work animals	Total
Dollars	*Percent*	*Percent*	*Percent*	*Percent*
Under 250......................	4.7	42.6	52.7	100.0
250 to 599.....................	7.7	64.4	27.9	100.0
600 to 999.....................	16.4	68.4	15.2	100.0
1,000 to 1,999.................	36.7	55.3	8.0	100.0
2,000 to 3,999.................	61.3	33.7	5.0	100.0
4,000 to 9,999.................	75.7	19.0	5.3	100.0
10,000 and over...............	72.8	19.1	8.1	100.0
All groups................	23.4	53.5	23.1	100.0

[1] See footnote 1, table 26.

About 1,054,000 farm operators, or nearly 18 percent of all operators, reported a total value of farm production ranging from $600 to $999. This group produced about the same total value of products as the lower two producing groups shown in table 26 combined. About two-thirds of the farmers in this group reported animal power only, and the other one-third was divided about equally between farmers having tractors and those owning no tractor or animal power. About one-fourth of these farms were subsistence farms in 1939.

The farms in these three low-producing groups made up nearly 4 million of the 6 million farms and produced only slightly more than one-fifth of the total value of farm production in 1939. These 3.9 million farms as a group were not highly mechanized in 1939 because very many of them were not physically and economically suited for mechanization. Many have very little cropland, many have rough topography, and many have unproductive soils. Operators of these farms are likely to get most of their income from livestock and livestock production from pasture lands and purchased concentrate feeds, and do not farm enough cropland to make their farms well suited to economical mechanization.

The fact that a few of these small farmers actually possess tractors (less than 10 percent) indicates that there may be others in this group who could afford to own tractors. Many other small farmers undoubtedly have some use of tractor power through exchange or custom

work. The rapidity with which these small farms become mechanized through the buying of tractors and tractor equipment depends on several things. The relationship between farm prices and the prices of tractors and tractor equipment is important. The possibility of obtaining tractors and power machines that are physically and economically suitable for farms that have small acreages and low crop-producing capacity must be considered. Expansion of partnership operation of farms so that one set of power equipment can be used in place of two sets, or three sets, of smaller, horse-drawn machines may be feasible in some areas.

The availability of used tractors and tractor equipment may offer some small farmers an opportunity for greater mechanization of their farms, where cost of new machines is prohibitive. Ownership of tractors by small farmers for off-farm work, such as threshing, combining, and sawmilling, may expand in some areas. Garden tractors, it is expected, will be found on many more small farms. Home-made tractors may appear on more small farms as automobiles and trucks become available for conversion.

The effects of these four factors to date on the number of tractors on small farms cannot be measured, but it is believed that they have been considerable. On January 1, 1947 there probably were well over 100,000 garden-type tractors, and about 50,000 home-made tractors on farms of all sizes. Most of these probably were on the smaller farms. Manufacture of garden-type tractors for all purposes reached about 100,000 units in 1946. In previous recent years the average manufacture was around 10 to 25 thousand a year.

From the standpoint of promoting efficiency of production for an important segment of production the greatest opportunity for further expansion of tractors and tractor equipment is on the farms that had a production in 1939 valued at $1,000 or more per farm. In 1939 ther were about 2.1 million such farms. This one-third of our farms produced almost 80 percent of the total value of farm products; one-half of them reported having tractors in 1940. Many probably had more than one tractor each, but almost 7 percent of them reported no tractors or work animals.

The change from animal power to tractor power has been greatest in the northern agricultural regions. In 1939, for example, a very large part of total agricultural production in the northern geographic divisions came from farms reporting tractors, whereas a large part of production in the Southern States came from farms reporting animal power only (fig. 9). The East North Central and West North Central States combined produced 42.5 percent of the total United States value of products. Twenty-eight percent of this came from farms that had only horses and mules; and 72 percent from farms that had tractors or no animal or tractor power. A relatively large part of the production of the Middle Atlantic, Mountain, and Pacific Coast States came from farms having one or more tractors. Relatively large parts of the production in the New England, East South Central, and Pacific Coast States came from farms reporting no tractors or work animals.

These comparisons show the production from farms that reported whether they had or did not have farm tractors and work stock. This does not necessarily mean that farms reporting work animals only, or those reporting no work stock or tractors, do not have the use of

custom or exchange tractors or of animals. The fact that about 1.4 million farms, or 23 percent of all farms in 1939, reported no tractor or animal power means, generally, that these farms are organized to operate without the actual ownership of these power units, rather than that their operations are underpowered. Operators of greenhouses and some commercial poultry enterprises who cultivate no land may have no reason to own tractors or work stock. Many fruit farmers in some areas hire all or a part of their field work done. On many such farms, motortrucks may represent the important power unit. Share-cropper farms in the South are operated with power and equipment owned by the "home farm."

VALUE OF PRODUCTS PRODUCED ON FARMS REPORTING DIFFERENT TYPES OF POWER, BY GEOGRAPHIC DIVISIONS, 1939
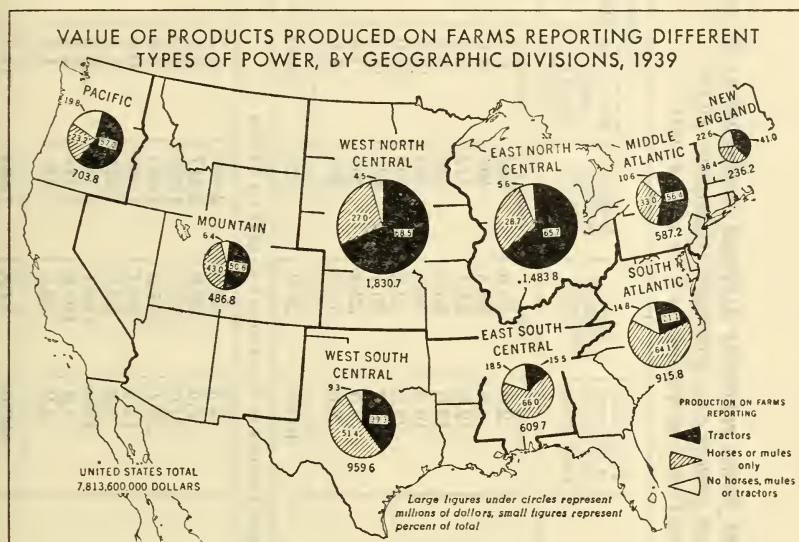
BAE 46399

FIGURE 9—A LARGE PROPORTION OF THE VALUE OF TOTAL FARM PRODUCTS OF 1939 WAS PRODUCED ON FARMS HAVING TRACTORS IN THE MIDDLE ATLANTIC, NORTH CENTRAL, AND PACIFIC COAST STATES. RELATIVELY LITTLE OF THE 1939 PRODUCTION OF THE SOUTHEAST CAME FROM FARMS HAVING TRACTORS.

These are the chief reasons why 7 percent of the farms of medium size and 6 percent of the large farms reported no tractor or animal power. Some farms with products valued at considerably more than $10,000 reported no tractors, horses, or mules. Relatively large proportions of these medium and large farms were in the Pacific Coast States (table 28). A relatively large proportion of the small farms reporting no ownership of tractors or work stock were in the South Atlantic and East South Central States.

In 1940, 4.5 percent of all farm operators in the United States reported the ownership of tractors but no work stock. These farms were operated entirely, or almost so, with tractor power alone for field work. Some such farms were reported in each size group in each geographic division, and were of greatest relative importance on the larger farms. Relatively large numbers of tractor-operated farms were reported in the North Central States, the West South Central States, and in the

TABLE 28.—*Size of farm and percentage of all farms reporting different combinations of tractor and animal power, by value of product groups and geographic divisions, 1939* [1]

FARMS WITH PRODUCTS VALUED AT LESS THAN $1,000

Geographic division	Percentage of all farms in U.S. in value group	Acres harvested per farm	Value of products per farm	Percentage of all farms in value group —			
				With horses and/or mules but no tractors	With horses and/or mules and tractors	With tractors only	With no tractors, horses or mules
	Percent	*Acres*	*Dollars*	*Percent*	*Percent*	*Percent*	*Percent*
New England	2.0	13.6	362	0.5	0.1	0.1	1.3
Middle Atlantic	4.6	20.3	408	2.0	.4	.4	1.8
East North Central	12.8	24.1	442	6.1	1.5	.8	4.4
West North Central	13.0	53.9	482	6.6	2.2	.8	3.4
South Atlantic	19.5	18.9	439	12.7	.4	.1	6.3
East South Central	22.8	19.8	392	15.0	.3	.1	7.4
West South Central	18.7	29.1	439	13.3	.6	.5	4.3
Mountain	3.0	32.4	404	1.8	.3	.1	0.8
Pacific	3.6	10.7	393	1.0	.2	.3	2.1
United States	100.0	26.3	429	59.0	6.0	3.2	31.8

FARMS WITH PRODUCTS VALUED AT $1,000 TO $3,999

Geographic division	Percentage of all farms in U.S. in value group	Acres harvested per farm	Value of products per farm	With horses and/or mules but no tractors	With horses and/or mules and tractors	With tractors only	With no tractors, horses or mules
New England	2.3	35.6	2,066	1.2	0.4	0.2	0.5
Middle Atlantic	7.5	53.6	2,017	3.5	3.0	.4	.6
East North Central	24.0	75.9	1,939	8.9	13.1	1.2	.8
West North Central	27.1	137.2	1,975	9.4	15.4	1.4	.9
South Atlantic	12.5	46.7	1,691	9.9	1.2	0.2	1.2
East South Central	6.3	54.7	1,620	4.6	0.9	0.1	.7
West South Central	10.9	106.1	1,736	5.6	3.0	1.6	.7
Mountain	4.5	102.8	2,016	2.5	1.4	0.3	.3
Pacific	4.9	42.5	2,049	1.8	1.0	0.8	1.3
United States	100.0	87.8	1,894	47.4	39.4	6.2	7.0

FARMS WITH PRODUCTS VALUED AT $4,000 OR MORE

New England	4.3	62.5	9,042	1.3	1.8	0.5	0.7
Middle Atlantic	9.5	88.7	8,317	1.7	5.6	1.4	.8
East North Central	19.5	176.5	7,263	1.4	16.4	1.3	.4
West North Central	26.6	247.3	7,713	3.0	21.3	1.7	.6
South Atlantic	7.1	159.1	9,440	2.5	3.4	0.5	.7
East South Central	3.2	179.3	8,266	1.2	1.8	(2)	.2
West South Central	9.3	272.1	10,626	2.5	5.2	1.2	.4
Mountain	8.3	239.9	10,653	3.0	4.2	0.7	.4
Pacific	12.2	201.8	12,336	2.3	5.0	3.2	1.7
United States	100.0	198.2	8,959	18.9	64.7	10.5	5.9

UNITED STATES TOTAL FOR ALL VALUE GROUPS

All geographic divisions	100.0	53.5	1,309	53.5	18.9	4.5	23.1

1 See footnote 1, table 26.
2 Less than one-tenth of 1 percent.

Pacific division. Some farms with both tractor and animal power were reported in each of the three size groups in each geographic division. Both tractors and work stock were used most extensively on the medium and large farms of the North Central States. Farms with horses and mules but no tractors were numerous in both the small and medium size groups, especially in the North Central and Southern divisions.

Any up-to-date summary of farmer use of tractor and animal power must consider the changes that have occurred since 1940. Data are not available for this purpose for different value-of-product groups, but are available for all farms as a group. From January 1, 1940 to January 1, 1945 the number of farms having tractors increased by approximately 607,000 and the number of tractors on farms increased by about 880,000. In this 5-year war period the increase in the number of farms having tractors was only 70 percent as great as the increase in the number of tractors on farms. This means that many farmers who already had one or more tractors took on one or two in addition. In 1940 the average for all farms reporting tractors was 1.1 tractors per farm, and in 1945, 1.2 tractors per farm.

This large wartime increase in tractor numbers raised the percentage of all farms that had one or more tractors from about 23 percent in 1940 to 33 percent in 1945. The wartime policy of increasing mechanical power and power machines on the larger and more productive farms probably means that 70 to 75 percent of the 2.1 million farms with production valued at $1,000 or more in 1939 had one or more tractors in 1945. As 7 percent of these farms reported no tractors or animal power in 1939, and supposedly are not generally in need of ownership of such power, only 20 percent, or about 400 thousand, did not have at least one tractor in 1945. Of the smaller farms, or those with a production valued at less than $1,000 in 1939, it is estimated that about 1.7 million had tractors, or no tractor or animal power in 1945. This leaves about 2.2 million small farms that had horses or mules but no tractors in 1945.

It now appears that tractors and tractor equipment on farms will continue to increase rapidly, as horses and mules continue to disappear and as new and more adaptable machines are manufactured. If tractors continue to increase during the next 5 years as fast as between 1940 and 1945, about 2.6 million farms will have tractors in 1950. If each of these farms has an average of about 1.2 tractors (the average per farm in 1945), there will be approximately 3 million tractors on farms at that time.

Mechanization on farms best suited for tractors and tractor equipment has gone a long way. If farmers continue to buy and keep tractors as indicated above, it might be that one or more tractors will be found on 90 percent of the farms that reported products valued at $1,000 or more in 1939, and on 18 percent of the farms that reported products valued at less than $1,000.

On January 1, 1947 there were about 2.7 million tractors on farms. Many of these were above normal average age because a large part of the wartime increase in tractor numbers came from the reconditioning of tractors that ordinarily would have been discarded. Most of these reconditioned tractors were put into use after 1942, and it is believed that the majority of them are still on farms. It is estimated that as many as 400,000 of the tractors on farms on January 1, 1947 nor-

mally would have been discarded by that date. Under favorable conditions another 400,000 might be available for discarding between January 1, 1947 and January 1, 1950. If these discards are actually made, there will be need for 800,000 tractors, plus another 400,000 tractors needed to increase the total number from 2.7 million in 1947 to around 3 million in 1950, or a total of 1.2 million new tractors between January 1, 1947 and January 1, 1950. These possibilities are in terms of field tractors, and do not include garden tractors, although the number of these probably will increase rapidly.

Growing Importance of Farm Electrification

At the middle of 1946 more than half the 6,000,000 farms of the United States had central-station electric power service. This is more than double the number that were so electrified in 1939, and nearly 5.5 times the number that had such service in 1930 (table 29). The rural electrification movement of the last 10 years is advancing rapidly.

TABLE 29.—*Farms in the United States with central-station electric service, 1925–46* [1]

Year	Farms electrified, January 1		Index of farm electrification growth (1936=100)
	Number	Percentage of total farms	
1925...............................	204,780	3.2	26.0
1930...............................	576,168	9.0	73.0
1935...............................	743,954	10.9	94.3
1936...............................	788,795	11.6	100.0
1937...............................	1,042,924	15.3	132.2
1938...............................	1,241,505	18.2	157.4
1939...............................	1,406,579	20.6	178.3
1940...............................	1,786,000	26.2	226.4
1941...............................	2,069,759	33.9	262.4
1942...............................	2,352,603	38.6	298.3
1943...............................	2,486,230	40.8	315.2
1944...............................	2,557,247	41.9	324.0
June 30, 1945........................	2,725,610	44.7	345.5
June 30, 1946........................	3,106,775	52.9	393.9

[1] Data for 1925–44 from Rural Electrification After the War, United States Department of Agriculture, A.I.S.–11, Feb. 1945; data for June 30, 1945 and 1946 from reports of Rural Electrification Administration, United States Department of Agriculture.

In 1943 the estimated value of major electrical equipment on farms in the United States was nearly 625 million dollars. About 63 percent of this value was in home appliances, including such items as radios, irons, washing machines, refrigerators, toasters, vacuum cleaners, and hot plates. Thirty-seven percent was in farm equipment, principally for the operation of brooders, water pumps and installations, miscellaneous electric motors, cream separators, milking machines, and milk coolers.

Thus, although far more electrical equipment is now found in rural homes and in farm barns, as yet it has had no appreciable effect on the principal farm machines and tools used in crop production. Widespread rural electrification is so new that a cumulative demand for

electrical equipment on farms that are already electrified will continue for some time. More ways will be found for using it, especially in and around buildings. On July 1, 1945, Michigan, New Jersey, and California led all States, with nearly 90 percent of the farms receiving electric service. More than 80 percent of the farms in several other States in the Eastern and Western parts of the United States were receiving electric service. Relatively small proportions of the farms in the Great Plains and Southern States had electric service in 1945 (see table 46 in the appendix).

MECHANIZATION AND PRODUCTION COSTS AND RETURNS

Mechanization and other technological developments usually enable farmers to produce more product with an hour of labor and a dollar's worth of power and equipment. Other things being equal, these efficiencies would result in lower production costs per unit of product, and this would mean greater profits to farmers or lower food prices in the markets, or both. The facts are, however, that "other things" do not remain the same. Prices of the things that farmers buy and prices of the things they sell both change constantly. Rents and wages change in agriculture, as in industry. Transportation and handling margins of distributors and retailers are by no means fixed over a period of time. The result is that although physical costs of each unit of farm output have decreased about one-fourth during the last quarter of a century, current money costs and prices of farm products have fluctuated so violently that there have been no definite sustained trends in current costs or real labor return per unit of output.

Total costs of agricultural production as affected by mechanization are here treated historically for the period 1910–45. Physical production costs are in terms of quantities multiplied by 1935–39 average prices, and current costs are in terms of quantities multiplied by current calendar-year prices. Differences between the two are the result of differences in prices of cost factors. Some of the comparisons are affected by the procedures used in computing costs of agricultural production and by conditions during the base period. These basic considerations are discussed early in this analysis. Special attention is given to segregating important operating-cost items that bear directly on the effect of mechanization on production costs. As much of the residual income (after cash costs) accrues to the farm operator and family labor, particular attention is given to the "real return" of farm labor, and to the influence of the labor item on operating costs of tractors, trucks, automobiles, other machinery, and horses and mules. Comparisons are made of net returns to the operator and family labor, and of wages paid to hired labor. The interchangeability of machinery and labor, and of power machines and animal-operated machines, in relation to production cost efficiencies, are analyzed.

The Base Period

The 1935–39 base period was used in the analysis of farm mechanization and production costs and returns. This period seems better suited in most respects for the analysis than other base periods that

are sometimes used in constructing series of index numbers. The years 1935–39 constitute the most recent prewar combination of 5 years, and a recent base is preferred to an old base. This period is used extensively as a base by the Bureau of Agricultural Economics and other agencies in constructing various series of index numbers which were useful in this study.

Two other base periods commonly used are 1910–14 and 1925–29. Table 30 compares pertinent economic conditions in the 1935–39 period with those in the other two commonly used periods. This comparison is made for the primary purpose of giving the reader an understanding of the relative economic position of farmers in 1935–39 and at two other important times during the 36-year period. This seems highly desirable to a proper understanding of the effects of mechanization on the welfare of farm people, as measured by costs and returns in agriculture.

TABLE 30.—*Relative economic position of farmers in the United States in specified base periods*

Item	Unit	Average of—		
		1935–39	1925–29	1910–14
Prices received by farmers.....	Index, August 1909–July 1914 = 100.	107	149	100
Prices paid by farmers including interest and taxes.......	Index, 1910–14 = 100....	128	168	100
Ratio of prices received to prices paid................	....do................	84	89	100
Farm employment............	Millions..............	10.9	11.4	12.1
Farm wage rates.............	Index, 1910–14 = 100....	118	179	100
Average value per acre of farm real estate................	Index, 1912–14 = 100....	83	121	[1] 100
Ratio of net land rent to land value................	Percent..............	5.1	6.0	[1] 4.4
Farm-mortgage interest rate...	....do................	5.0	6.1	6.1
Short-term interest rate.......	....do................	6.3	7.6	8.7
Crop yields per harvested acre[2].	Index, 1910–14 = 100....	105	99	100
Farm output per worker......	....do................	139	128	100
Labor returns per farm worker.	Current dollars........	386	464	258
Labor returns per operator and family worker.............	....do................	394	475	254
Labor returns per hired farm worker...................	....do................	362	433	271
Real labor returns per farm worker...................	Average 1935–39 dollars.	386	354	318
Real annual wages per industrial worker[3].............	....do................	956	1,033	815
Ratio: Real labor returns per farm worker to real annual wages per industrial worker[4].............	Percent..............	40	34	39

[1] Average of 1912–14.
[2] Combined yields of 18 field crops and 10 fruit crops.
[3] Adjusted for unemployment.
[4] For an explanation of the apparent relatively low returns to farm labor in all 3 periods see text, p. 73.

Both prices paid and prices received by farmers were higher in 1935–39 and in 1925–29 than in 1910–14. Prices paid increased faster than prices received so that the ratio of prices received to prices paid was less favorable in 1925–29 than in 1910–14, and still less favorable in 1935–39. Counting 1910–14 as 100, the ratio in 1925–29 was 89, and the ratio in 1935–39 was only 84. The less favorable position of prices received, when compared with prices of cost inputs, in 1935–39 is much less significant than seems apparent from this comparison alone. The number of farm workers was lower and farm output per worker was higher in both 1925–29 and 1935–39 than in 1910–14. The result was that even though prices of farm products in the base period used here were relatively low compared with those of the other 2 base periods, real labor returns per farm worker were higher than in 1910–14 by 11 percent in 1925–29 and by 21 percent in 1935–39. This fact is one of the compelling reasons for using a recent base period in the sort of analysis made in this part of the publication.

Yields of crops per harvested acre were about the same in 1910–14 and 1925–29. Yields in 1935–39, however, averaged 5 percent higher than in the other two periods, despite the adverse effect of the 1936 drought. Good growing conditions in the last 3 years of the 1935–39 period more than offset the low yields in 1936. For the United States as a whole, the period 1935–39 on the average did not represent extreme growing conditions.

Other comparisons contained in table 30 show that land values per acre in the United States were about a fifth higher in 1925–29, and 17 percent lower in 1935–39 than in 1912–14. Farm-mortgage rates and short-term interest rates were also lower in the two later base periods than they were in the 1910–14 period. On the other hand, land rents were higher in relation to land values in both recent periods than in 1912–14, averaging 36 percent higher in 1925–29, and 16 percent higher in 1935–39. These increases are in the same direction as increases in real labor returns per worker shown above.

Farm operators and members of their families received on the average about 10 percent more a year for their work than hired workers in 1935–39 and 1925–29, but in 1910–14 hired workers were paid somewhat more than the farm operators and family workers had left for their work. The ratio of real labor returns of all farm workers to real annual wages of industrial workers was about the same in both 1935–39 and 1910–14, but the ratio was less favorable to farm workers in 1925–29.

All in all, the period 1935–39 can be characterized as one that represents a middle field of economic relationships in farming. Farmers and farm workers were not extremely bad off nor were they exceptionally well off. The 1935–39 period includes recent items of mechanization and production, and takes into account recent influences of physical efficiencies in production. From this standpoint it becomes more acceptable than earlier periods in any analysis of costs and returns in agriculture, as affected by mechanization.

Importance of Power and Machinery Costs

The production costs used herein are net costs to agriculture in the aggregate. (See footnote 1, table 31). The costs include a land charge,

a charge for family and operator labor, cash expenditures for hired labor, fertilizer and other items not produced by farmers, and allowances for depreciation of buildings and equipment. Labor of the farmer and his family was charged to agriculture on the basis of prevailing

TABLE 31.—*Total production costs of agriculture, United States, 1935–39 average* [1]

Item	Farm labor [2]	Other costs [3]	Total costs	
			Amount	Proportion of all costs
	Million dollars	*Million dollars*	*Million dollars*	*Percent*
Tractors.........................	15	344	359	4
Trucks..........................	10	209	219	3
Automobiles [4]...................	20	333	353	4
Other machinery.................	58	441	499	6
Farm-produced power.............	341	699	1,040	12
Other farm labor [5]..............	3,014	....	3,014	36
All labor, power and machinery.....	3,458	2,026	5,484	65
All other costs [6]...	....	2,973	2,973	35
Total.....................	3,458	4,999	[7] 8,457	100

[1] The total costs shown in this table cover about 97 percent of all production costs, cash and noncash. Noncash items were valued at cash-cost rates. A rental charge for all farm land was estimated from total net rent paid on land rented and the proportion that the value of rented land was of the value of all farm land. Several types of data were utilized in estimating the value of unpaid operator and family labor—the hired-wage bill, estimates of man-hour requirements of farm production, hired and family farm-employment and farm-wage rates—in order to charge the same rate per man-equivalent hour for both hired and unpaid labor. Interest charges on property other than real estate were calculated from value of investment and current interest rates on short-term credit. Annual depreciation charges for machinery and buildings were used instead of annual cash expenditures.

The costs shown are substantially "net costs to agriculture". For example, costs of feed and livestock bought by farmers were not included, since such items are largely sales by one farmer to another. Double counting would occur if such costs had been included since the cost of the feed to agriculture is already reflected in the labor, machinery, rent, fertilizer, and other items included as costs.

Most of the data upon which the cost estimates were based are contained in the BAE processed report, *Net Farm Income and Parity Report: 1943* and summary for 1910–42, July 1944.

[2] Estimated costs of farm labor used in the repair, maintenance, and housing of motor vehicles and machinery were allocated to these items. Labor costs for chores, housing, and raising of horse and mule feed were estimated for farm-produced power.

[3] Other costs of power and machinery items include depreciation, operating expenses, repairs, skilled nonfarm labor, insurance, and allowances for taxes, interest, and housing. Machinery and power costs of raising horse and mule feed are included in the respective power and machinery items but are excluded from costs of farm-produced power.

[4] Only the farm-production share of automobile costs is included.

[5] Includes costs of all farm labor other than those allocated to power and machinery costs.

[6] Includes rent, interest, fertilizer, and other cost items not allocated to power and machinery costs.

[7] The total costs of 8.5 billion dollars shown here are 1 billion less than the adjusted gross income to agriculture for this period. (See footnote 9, page 69 for an explanation of adjusted gross income). About one-third of this difference of 1 billion dollars results from an incomplete measurement of total costs. The remaining difference of two-thirds billion dollars means that operators and family workers received 5 cents more labor returns per hour of work than hired workers received during the 1935–39 period. Wage rates paid to hired workers were used in calculating total labor costs.

rates for hired labor. The net costs to agriculture represent what all farmers as a group would have to recover in cash expenses paid to those not engaged in farming, and to cover depreciation of buildings and equipment, going wages for operator and family labor, customary short-time mortgage rates for working capital, and average rentals paid by tenants for the use of land. The costs, therefore, include not only cash expenses, but allowances for non-cash production items as well.

Computed in this way the total production costs of agriculture averaged during the base period, 1935–39, about 8.5 billion dollars (table 31). Nearly 3.5 billion dollars of the total was for farm labor, approximately 27 percent of which was hired; about 5 billion dollars were for all other production costs. About 13 percent of the cost of all farm labor in the base period was for farm-produced power and maintenance of machinery, and 87 percent represented all other farm labor costs. Of the power and machinery labor costs, nearly 80 percent was for farm-produced power, including labor costs for producing horse and mule feed and caring for the work stock and colts; only 20 percent was for farm servicing of tractors, trucks, automobiles and other machinery and tools. All labor, power, and machinery costs in agricultural production in the base period amounted to nearly two-thirds of all production costs.
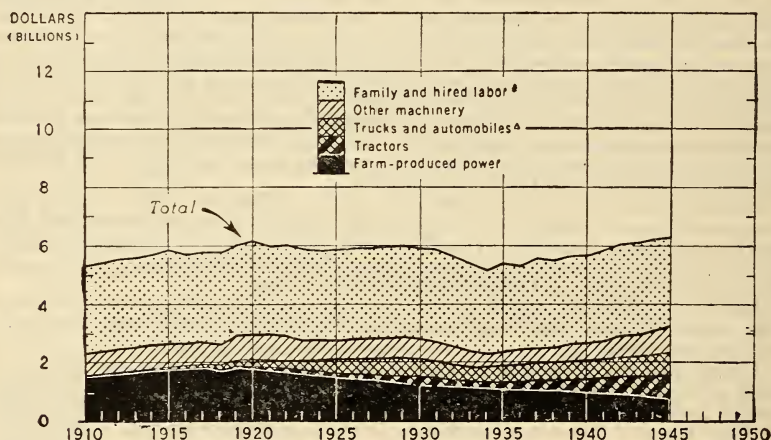
* ALL FARM LABOR COSTS EXCEPT THOSE FOR SERVICING AND MAINTENANCE OF MACHINERY, TRUCKS,
AUTOMOBILES, AND TRACTORS, AND FOR CARE AND MAINTENANCE OF AND GROWING OF FEED FOR
HORSES AND MULES, WHICH ARE INCLUDED IN THE POWER AND MACHINERY COST ITEMS.
△ INCLUDES ONLY FARM PRODUCTION SHARE OF AUTOMOBILE COSTS.

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FIGURE 10—TOTAL PRODUCTION COSTS OF FARM POWER, MACHINERY, AND LABOR,
UNITED STATES, 1910-45.
(COSTS IN 1935-39 AVERAGE DOLLARS)

In terms of 1935–39 average dollars, total operating costs of farm power, machinery, and labor have varied from a low of 5.2 billion dollars in 1934 to a high of 6.3 billion dollars in 1945, a range in 36 years of only about 20 percent. More costs of operating power machines have made up for reductions in costs of work stock.

Measured in terms of 1935–39 average dollars, the total physical costs of farm labor, power, and machinery have remained remarkably stable over the 36 years, 1910–45, despite a large increase in farm pro-

duction. The interwar peak of these physical costs was reached in 1920 when inventories of horse-drawn and power machines were piling up, and the low point was reached in the depression year, 1934, when machinery purchases and operating costs were being reduced drastically (fig. 10). The peak volume of physical costs reached in 1920 was exceeded slightly in 1944 and 1945.

Millions of horses and mules have been replaced since World War I by motor vehicles and modern power-operated machines without any appreciable increase in total operating costs of power and machinery. But the change in composition of farm power and machinery has made possible a large increase in farm production with fewer man-hours of labor.

During 1910–14 about one-fifth of all man-hours used on farms were devoted to producing horse and mule feed and to caring for horses and mules and servicing farm machinery and equipment. This meant that more than one day out of every week of work, exclusive of Sundays, was spent on such work. During 1942–45, total man-hours of farm labor used on all farm power and machinery made up only slightly more than 11 percent of the total hours in agriculture, an equivalent of two-thirds of a day out of each week of 6 work days (table 32). This decrease is due largely to the decline of farm-produced power. Horses and mules in 1945 required only about 1.4 billion man-hours, including hours for producing their feed, compared with an average of 3.7 billion hours in 1910–14.

Effect of Prices on Production Costs

The rather stable production costs of farm power, machinery, and labor shown in figure 10 in terms of 1935–39 prices become decidedly unstable when expressed in current dollars as in figure 11. Sharp ups and downs are evident in production costs because of high and low prices of power and machinery cost factors in periods of war and depression. The range in current dollar costs is from a low in 1933 of less than 4 billion dollars to a high in 1945 of 13.4 billion dollars, a difference of 250 percent compared with a range from low to high of only 22 percent when computed at average 1935–39 prices.

Fluctuations were much less violent in the current operating costs of machinery than in the operating costs for farm-produced power and farm labor. High farm wages and high prices of horse and mule feed in the war periods, and low wages and feed prices in the depression periods are largely responsible for the tremendous fluctuation in total current costs for all farm labor, power, and machinery.

The labor cost shown in these calculations includes the return that farm operators and their families would have received if they had been paid for their farm work at prevailing wage rates for hired farm workers. When wage rates paid hired workers were low *all* workers on farms were receiving low returns for their efforts, and when wage rates were high *all* workers on farms were getting higher returns for their contribution to production. A part of the labor force was actually hired at these rates by farm operators, but usually about 75 percent of the work was done by operators and members of their families. They received their labor returns from net farm income after other expenses were paid.

TABLE 32.—Farm labor requirements for care and maintenance of horses and mules, motor vehicles, and machinery, and labor requirements for other farm work, United States, specified periods and years, 1910–45

Period or year	Man-hour requirements for—[1]								Proportion of total farm work required for all power and machinery
	Farm-produced power			Servicing and maintenance of—		All power and machinery	All other farm work	Total farm work	
	Growing horse and mule feed	Chore and overhead work	Total	Tractors, trucks, and automobiles[2]	Other farm machinery				
	Million hours	Million hours	Million hours	Million hours	Million hours	Million hours	Million hours	Million hours	Percent
Average of:									
1910–14	1,714	1,956	3,670	7	589	4,266	18,240	22,506	19
1915–19	1,711	2,092	3,803	42	569	4,414	18,581	22,995	19
1920–24	1,598	1,952	3,550	117	599	4,266	18,507	22,773	19
1925–29	1,311	1,706	3,017	199	485	3,701	18,657	22,358	17
1930–34	1,085	1,392	2,477	236	440	3,153	18,234	21,387	15
1935–39	919	1,143	2,062	262	345	2,669	17,904	20,573	13
1940–44	646	961	1,607	329	478	2,414	18,460	20,874	12
1940	736	1,021	1,757	295	409	2,461	17,951	20,412	12
1941	699	996	1,695	309	430	2,434	18,183	20,617	12
1942	623	967	1,590	331	474	2,395	18,737	21,132	11
1943	591	932	1,523	349	527	2,399	18,627	21,026	11
1944	582	889	1,471	361	551	2,383	18,799	21,182	11
1945	550	843	1,393	381	613	2,387	18,268	20,655	12

[1] See footnote 2, table 5.
[2] Includes farm labor on only that share of automobiles used in farm production.
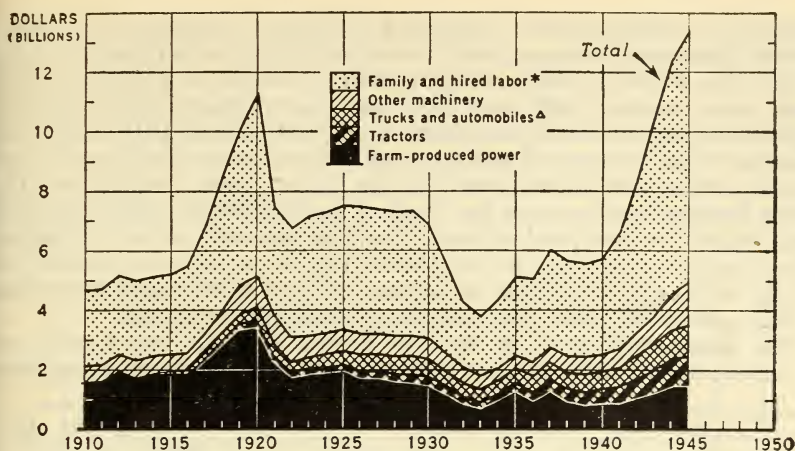
DOLLARS
(BILLIONS)

Total

☐ Family and hired labor*
▨ Other machinery
▧ Trucks and automobiles△
▨ Tractors
■ Farm-produced power

1910 1915 1920 1925 1930 1935 1940 1945 1950

*ALL FARM LABOR COSTS EXCEPT THOSE FOR SERVICING AND MAINTENANCE OF MACHINERY, TRUCKS.
AUTOMOBILES. AND TRACTORS. AND FOR CARE AND MAINTENANCE OF AND GROWING OF FEED FOR
HORSES AND MULES. WHICH ARE INCLUDED IN THE POWER AND MACHINERY COST ITEMS.
△INCLUDES ONLY FARM PRODUCTION SHARE OF AUTOMOBILE COSTS

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FIGURE 11—TOTAL PRODUCTION COSTS OF FARM POWER. MACHINERY. AND
LABOR. UNITED STATES. 1910-45.
(COSTS IN CURRENT DOLLARS)

Wide fluctuations in operating costs of power, machinery, and farm labor are caused by severe changes in prices of these cost factors rather than by changes in volume of the cost factors. (See figure 10).

The first 3 sections in figure 12 emphasize the shift in composition of power costs. Aggregate costs of farm-produced power in terms of 1935–39 average prices have declined rapidly since 1919, but as the volume of farm output has increased over the period, costs per unit of output have declined faster than total costs. On the other hand, total physical operating costs of tractors, and trucks and automobiles, have gone up since 1910, with physical costs per unit of farm output increasing less rapidly than total costs.

The fourth section in figure 12 is for machinery other than tractors, trucks and automobiles. Even though the composition of this machinery item has changed drastically, the index of operating cost per unit of output was decidedly downward until just before the recent war.

In section 5 of the illustration the indexes of aggregate operating costs of farm-produced power and other machinery have been combined with the indexes of operating costs of tractors, automobiles, and trucks. The result is a relatively flat trend in total physical costs since World War I but a decided downward trend in the index of production costs per unit of farm output. This comparison emphasizes the increase in physical efficiency of farm power and machinery because of the marked increase in volume of farm output and the change in composition of machinery and power.

Section 6 of figure 12 brings out the effect of substitution of machinery and power for labor. Thus, when physical costs of all farm labor are combined with those for power and machinery, the total costs show virtually a flat trend over the entire period. The strong upward trend in farm output, with practically a constant volume of

production costs for labor, power and machinery, has brought a reduction of physical costs per unit of output of about 33 percent since World War I (1919–1945). This means that farmers as a group in 1945 were using one-third less total labor, power, and machinery combined, to produce one unit of farm output than was used in 1919. A part of this reduction in physical costs per unit must be ascribed to nonfarm workers who have contributed indirectly to these reductions. The sharp fluctuations in costs per unit of production in 1934 and 1936 were caused by low production during the unusually severe droughts. The notable fluctuations in the World War I period were caused primarily by yearly variations in volume of farm output and in volume of farm-produced power and machinery available to farmers.

The production costs in 1935–39 dollars (fig. 12) are reproduced in current dollars in figure 13. Comparison of the corresponding sections
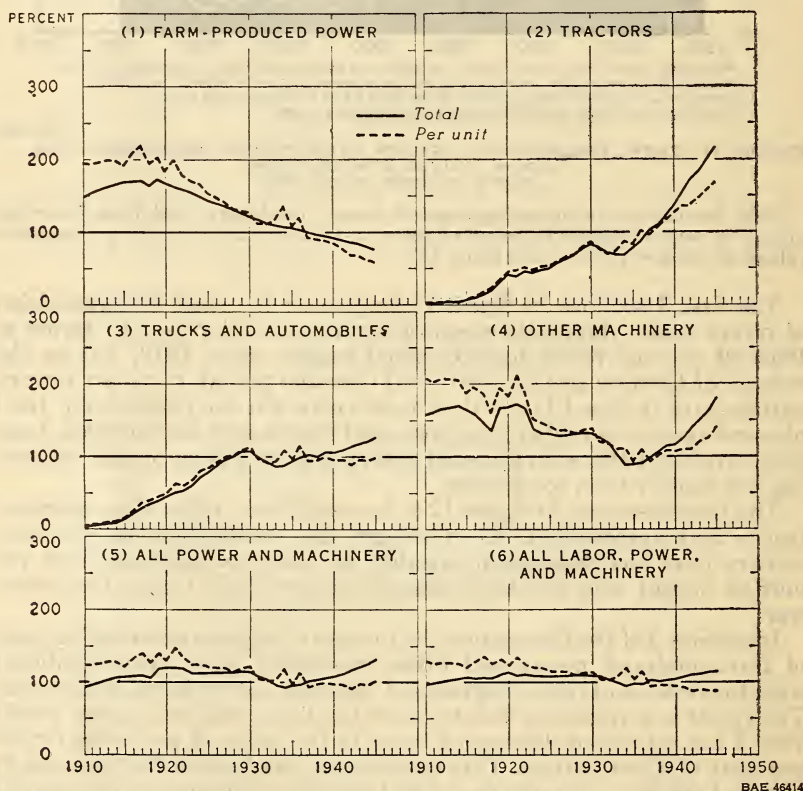
FIGURE 12—TOTAL PRODUCTION COSTS AND COSTS PER UNIT OF FARM OUTPUT FOR FARM POWER, MACHINERY, AND LABOR, UNITED STATES, 1910-45. (COSTS IN 1935-39 AVERAGE DOLLARS; INDEX NUMBERS 1935-39=100)

Total physical costs of farm-produced power have decreased while physical costs of tractors and automobiles and trucks have increased. When these are combined with total costs of other machinery into a single index the result is a relatively flat trend in the total but a decided downward trend in the cost index per unit of farm output. The addition of physical costs of farm labor results in a flatter trend for the total and a sharper downward trend in physical costs per unit of farm output.

of the two emphasizes the strong influence of prices and of farm-produced power on production costs of labor, power, and machinery. Section 2 of figure 13 shows that the long-time upward trend of current dollar operating costs of tractors does not differ greatly from the trend of costs in constant dollars. The relatively smooth upward trend in costs of operating tractors, therefore, was largely the result of increased volume, although prices of cost factors had a noticeable effect on total costs in the two war periods and during the depression of the 1930's.
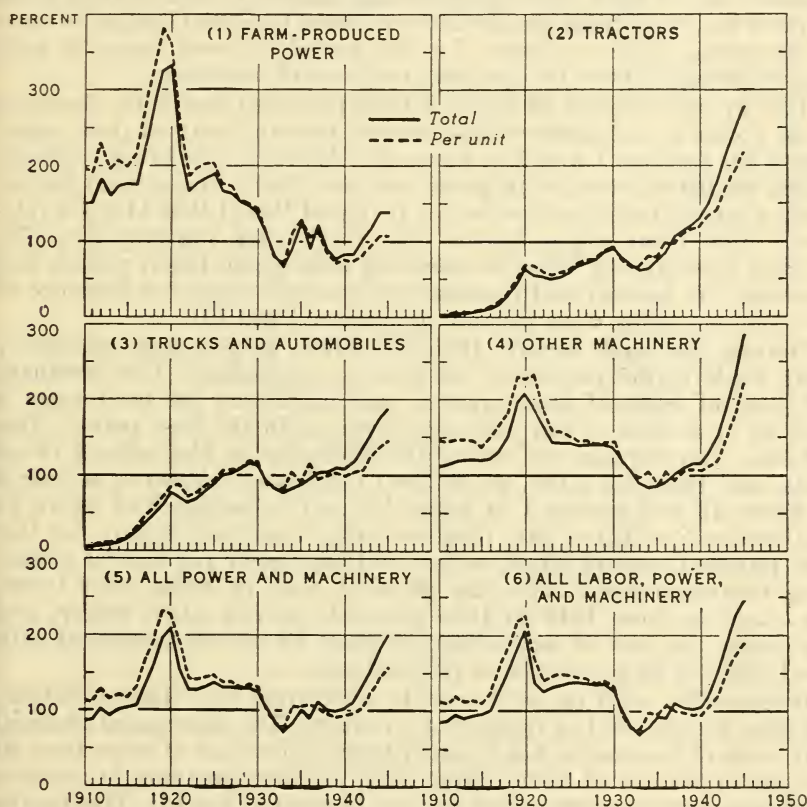
FIGURE 13—TOTAL PRODUCTION COSTS AND COSTS PER UNIT OF FARM OUTPUT FOR FARM POWER, MACHINERY, AND LABOR, UNITED STATES, 1910-45. (COSTS IN CURRENT DOLLARS; INDEX NUMBERS 1935-39=100)

These current dollar costs when compared with constant dollar costs (fig. 12) bring out the strong influence of prices on production costs of labor, power, and machinery. Operating costs of tractors, and automobiles and trucks, have been influenced less by price changes than have costs of farm-produced power, other machinery, and farm labor.

In contrast to operating costs of tractors, costs of farm-produced power have been influenced rather severely by price changes. Consequently, when plotted in current-dollar costs they do not show the smooth trend shown when plotted in constant-dollar costs. The indexes

of total current-dollar costs of farm-produced power varied more than 400 percent from a high in 1920 to a low in 1933. The higher costs in 1920 were due to more animals and to higher maintenance costs. Wide variations in feed prices and wages of farm labor were principally responsible for more than one-half of this wide variation in total costs of farm-produced power. In terms of constant dollars, the variation for the same period was about 150 percent.

The upward trend in the combined operating costs of automobiles and trucks, based on current prices, was largely the result of increasing numbers up to 1930, although prices influenced total operating costs of these machines considerably in the two war periods. Changes in costs of operating "other machinery" in the period between the wars were mainly brought about by changes in volume of machinery.

The strong influence of costs of farm-produced power on the costs of all power and machinery is shown by the similarity of data represented by sections 1 and 5 in figure 13. When current labor costs are added to current costs of all power and machinery, the general picture is not changed much, except for the period of World War II when relatively high farm wages boosted the total costs substantially. The striking dissimilarity between operating costs of all labor, power, and machinery in current and constant dollars emphasizes the influence of prices on operating costs (section 6, figures 12 and 13).

During the base period, 1935–39, labor, power, and machinery costs made up 65 percent of all costs to agriculture. The dominant influence of costs of labor, power, and machinery on total costs is evident in periods of war and depression, as in the base period. This influence can be seen by noting the similarity of the indexes of all costs, and those for labor, power, and machinery (shown in section 6 of figure 12 and section 1 of figure 14; and in section 6 of figure 13 and section 2 of figure 14). This similarity is striking despite the fact that physical costs of labor, power, and machinery per unit of output have decreased faster than the physical costs of some other items. For example, from 1919 to 1945 physical costs of labor, power, and machinery per unit of output were reduced 33 percent compared with a reduction of 26 percent in all physical costs.

Historically, total physical costs in agriculture have been decidedly constant during the last quarter of a century. The decrease in physical unit costs of one-fourth has resulted from an increase of more than 40 percent in volume of farm output with an accompanying increase in total operating costs of only 8 percent (section 1, fig. 14). This means that if there had been no increase in farm-production efficiency during the last 25 years, total cost for the larger volume of production in 1945 would have been 33 percent higher than it actually was. It means, also, that most of the increased efficiency in agricultural production when expressed in terms of production per unit of input has been the result of greater total production rather than a result of any decrease in total volume of production inputs.

Over the third of a century shown, prices of cost goods have fluctuated so violently that price changes have over-shadowed the changes in physical efficiency in agriculture as a whole. Annual average farm wages per day without board, for example, varied during the 36 years from $1.11 in 1933 to $4.34 in 1945. Farm prices of corn, an influential

item in the cost of farm-produced power, varied from about 32 cents per bushel in 1932 to about $1.52 in 1918. But despite price changes farmers who reduced their costs have had larger net incomes than they would have had without reductions in costs.
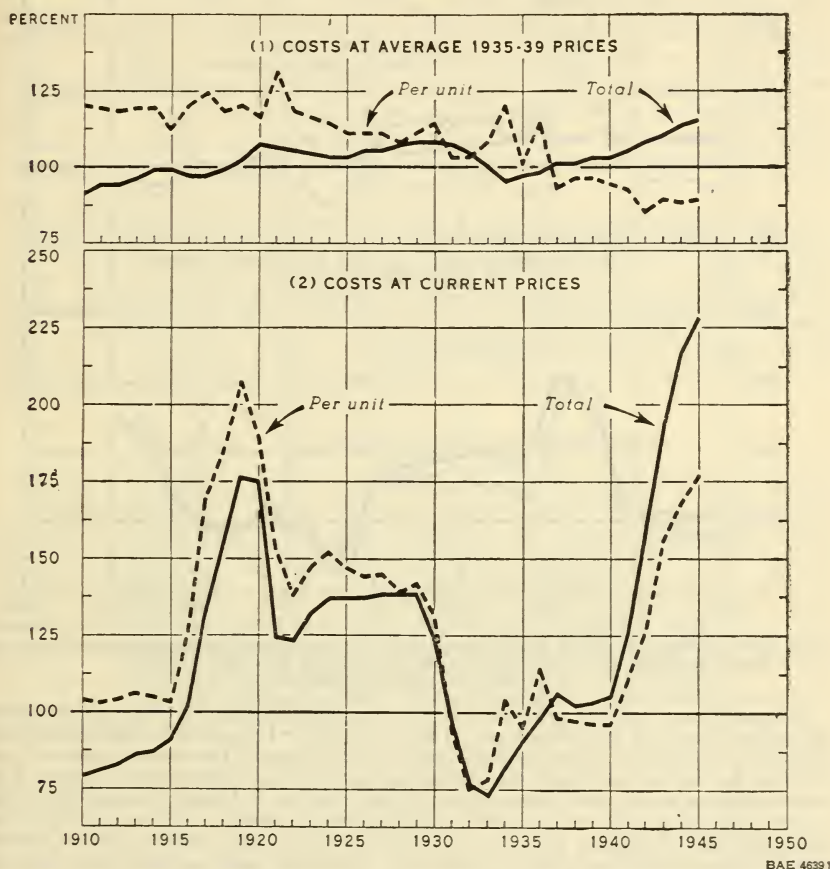
FIGURE 14—TOTAL PRODUCTION COSTS AND COSTS PER UNIT OF FARM OUTPUT, UNITED STATES, 1910-45. (INDEX NUMBERS, 1935-39=100)

As about two-thirds (65 percent in 1935–39) of all operating costs in agriculture are for labor, power, and machinery, these items are dominating factors in the trend of all costs. This influence may be observed by comparing the indexes of all costs shown here with the indexes of labor, power, and machinery costs shown in figure 13.

An understanding of the dominating influence of prices of cost factors on unit production costs can be had by comparing sections 1 and 2 of figure 14. For example, section 2 shows that the difference in costs per unit of farm output between the high point in 1919 and the low point in 1932 was 132 index points, but when the influence of price changes was eliminated, as in Section 1, the difference was only 17 points. From 1932 to 1945 the trend in current production costs was reversed, and total cost per unit of output increased rapidly, chiefly because of increasing prices rather than because of the use of increasing
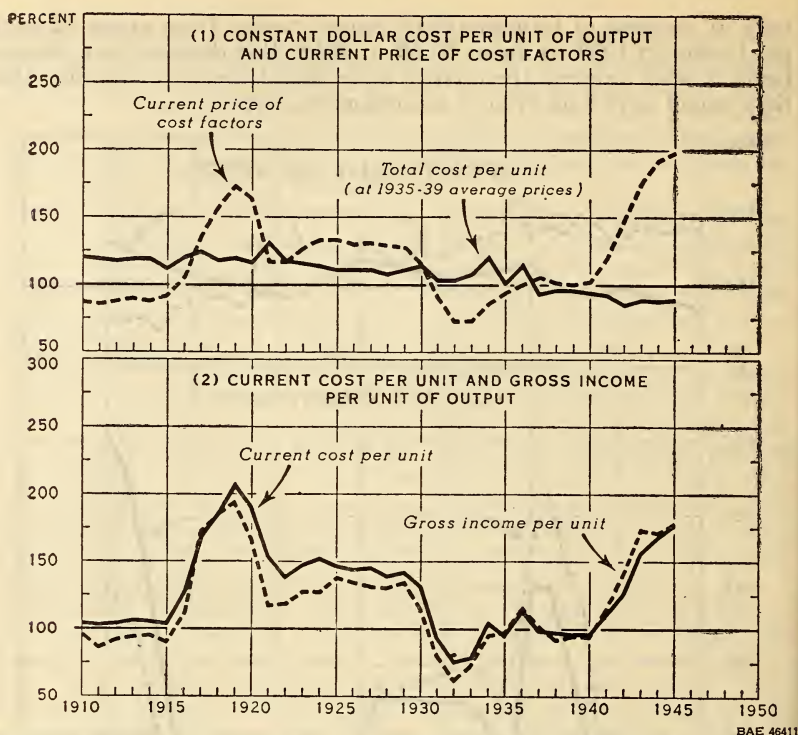
FIGURE 15—RELATION OF PRICE OF COST FACTORS AND PRODUCTION COSTS TO GROSS INCOME PER UNIT OF OUTPUT, UNITED STATES, 1910-45.
(INDEX NUMBERS 1935-39=100)

Fluctuations in current prices of cost factors are responsible for the wide variations in current costs per unit of output. In the World War II period, current-dollar costs per unit of output increased less than prices of cost factors because of increased production per worker and per unit of machinery. The close relationship between land rent and farm wages, and farm prices of farm products, is largely responsible for the close relationship between current costs and gross income per unit of output. When costs per unit are higher than gross income per unit, many farm operators receive less for their labor and/or use of land than the wages paid to hired labor and the rents paid by tenants.

quantities of cost goods per unit of output. The increase in current dollar costs amounted to 102 index points compared with a decrease in 1935–39 average dollar costs of 14 index points. The increase in prices of all cost factors combined [8] from the depression year of 1932 to the war year of 1945 was 126 index points, or about 170 percent (section 1, fig. 15). So long as prices of input factors are influenced so strongly by periods of prosperity and depression we cannot expect that a decreasing trend in physical costs will be paralleled by a decreasing trend in dollar costs.

[8] The index of current prices of cost factors was calculated by dividing the index of total current costs by the index of total costs at 1935–39 average prices. As the index of costs at 1935–39 average prices is essentially a weighted-average measure of volume of physical inputs, this method gives a measure of weighted-average price changes of labor, power, machinery, fertilizer, rent, etc.

Other aspects of the farm-cost problem should be mentioned here. In the first place, the net returns that farmers get for their products depend upon prices of the products as well as upon prices of cost goods. This phase of the problem is discussed under the next heading, Agricultural Costs and Returns. In the second place, as production costs include wages for hired labor and for farm operators and family workers, changes in wage rates reflect changes in labor returns to farm people as well as changes in production costs. Individual operators who have reduced their cash operating costs, or increased their output per unit of cash cost, have obtained higher net incomes, or have had more left as wages for themselves and their family workers, than they would have had with no increase in operating efficiency.

Increased physical efficiency in agricultural production has been a fairly persistent and stable force over a long period, tending always to decrease the cost of production per unit of output. On the other hand, prices of the things farmers buy or furnish for production purposes have fluctuated so violently that increased production efficiency has not at all times meant a corresponding increase in income, or in returns for the labor of farm people.

Agricultural Costs and Returns

Prices received by farmers for the products they sell are also subject to wide fluctuations, as are the prices of things they buy. Price levels of both, therefore, are determined largely by over-all economic conditions, the greatest fluctuations occurring in periods of war and depression. Although prices of the things the farmer buys may respond more slowly to economic conditions than prices of the things he sells, in general, changes in prices received and changes in production costs per unit move together. This close relationship is brought out in section 2 of figure 15, where current costs per unit of output are compared with average prices per unit, as measured by gross income per unit.[9]

One outstanding reason for the general tendency for total costs to be low in periods of low income and high in periods of high income is that income received greatly influences the farm wages and land rents that will prevail. These cost items are largely "imputed costs," and are at the same time largely "imputed returns" to farm people for their labor and their land.[10] During the base period these two items made up more than 60 percent of the imputed total costs to agriculture as computed here.

Because a large part of the costs of rent and labor to agriculture represents what is left for the farm families' labor and investment

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[9] The index of gross income per unit of output was computed by dividing the index of gross income by the index of farm output. The index of gross income was constructed from the gross income figures reported by BAE, adjusted to make them comparable in content to the production cost figures. BAE gross income includes cash income from marketings of crops and livestock, plus the value of farm products consumed in the home, plus the rental value of farm homes, plus amounts received in Government payments. This total was adjusted by subtracting costs of feed and livestock bought by farmers, and by adding or subtracting plus or minus changes in inventories.

[10] Not all of the land is owned by farm people; nor is all of the work done by farm workers but, broadly speaking, most of the land and labor costs constitute returns to farm people.

after paying cash operating expenses and charging off depreciation, "low costs" that are brought about by low wages and rents frequently mean low income to agriculture. Low costs of this kind work in the opposite direction from low costs that are the result of increased efficiency in production. Furthermore, the volume of costs of labor and rent is so large, and the fluctuations in these costs are so great that these imputed costs dominate the cost and returns situation in agriculture.
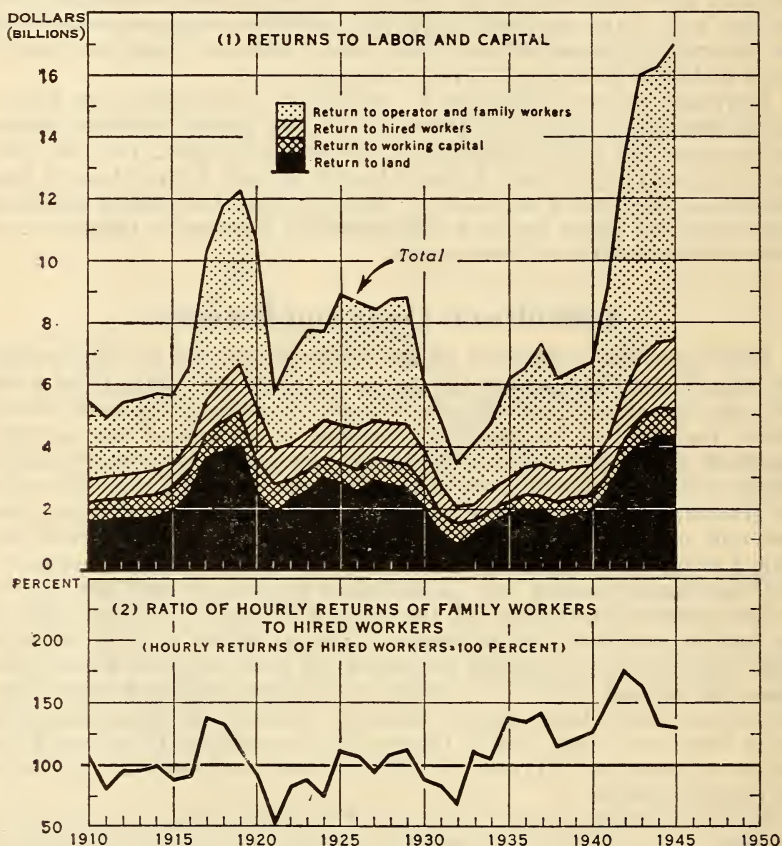
FIGURE 16—RETURNS TO ALL FARM LABOR AND CAPITAL, AND RELATIVE RETURNS TO FAMILY AND HIRED LABOR, UNITED STATES, 1910-45.

In 15 of the 36 years from 1910 to 1945, farm operators and unpaid family workers averaged less labor return per hour than did hired farm workers. Returns to farm labor and capital fluctuate with changes in prices occasioned by wars and depressions.

The amount left for the use of land, labor, and capital after deducting all other operating costs from gross income to agriculture has varied during the 36 years, 1910–45, from a low of about 3.5 billion dollars in 1932 to a high of 17 billion dollars in 1945 (section 1, fig. 16). Not only were returns to labor and capital high in 1945, but both cash

and total costs were high and farm prosperity was very high, compared with depression and farm foreclosure conditions in 1932 when cash costs, total costs, and returns to labor and capital were very low. Here again, prices of the products sold completely dominated the situation. Efficiencies in production brought about by mechanization and other technological developments could not possibly offset the effects of 40-cent wheat, 6.5-cent cotton, and 3.5-cent hogs.

It appears that, over the third of a century of wars and peace from 1910 to 1945, farmers as a group have earned high wages only in the war periods, after allowances are made for returns to land and farm working capital at prevailing rates. The war years are the outstanding periods in which the farmer and his family received net more per hour for their labor than they paid to hired farm workers (section 2, fig. 16). The same was true during the recovery period following the depression of the 1930's, but in the depression years and during the years before and after World War I, farmers' net return per hour for their labor averaged less than wages paid to hired workers. But it is necessary to recall, here, that farmers in general pay more for land rents and for land, in periods of relative prosperity, and the higher income imputed to land reduces to some extent the returns for their labor.

TABLE 33.—*Annual returns to all farm labor, hired workers, and operator and unpaid family workers, by periods, United States, 1910–44* [1]

Period	Total returns			Returns per worker		
	All farm labor	Hired workers	Operator and family workers	All farm labor	Hired workers	Operator and family workers
	Million dollars	*Million dollars*	*Million dollars*	*Dollars*	*Dollars*	*Dollars*
Average of:						
1910–14..............	3,112	784	2,328	258	271	254
1915–19..............	5,254	1,139	4,115	451	394	470
1920–24..............	4,520	1,301	3,219	397	450	379
1925–29..............	5,269	1,280	3,989	464	433	475
1930–34..............	2,897	736	2,161	262	287	254
1935–39..............	4,219	928	3,291	386	362	394
1940–44..............	8,293	1,557	6,736	803	634	856

[1] Return to operator and family labor is the difference between gross income in agriculture and total production costs exclusive of the imputed costs of operator and family labor. Yearly labor returns per worker were determined by dividing total labor returns to operator and family workers by their average annual employment, and by dividing total wages and perquisites paid to hired labor by hired average annual employment.

It must be remembered that these comparisons are purely relative. They have little bearing on the question of adequate returns to farmers and hired men for their labor. During 1930–34, for example, farmers as a group received only $254 per worker for their year's work; hired men averaged $287 per worker. Living costs were low during these years, but cash was very scarce. In 1940–44, a period of relatively high living costs, labor returns per operator and family worker averaged $856 per year, compared with $634 per hired worker (table 33). It should be noted that these returns to labor do not in the case of operator, family worker, or hired worker, represent cash available for spend-

ing. Living supplies furnished by the farm are included in gross income, and the procedure followed allowed the operator a return for the use of his land and working capital before returns to labor were computed. If the farm was owned and free of debt, this allowance would be available for personal expenses or for savings. Members of the family who had jobs off the farm may have added to the funds available for living and savings.
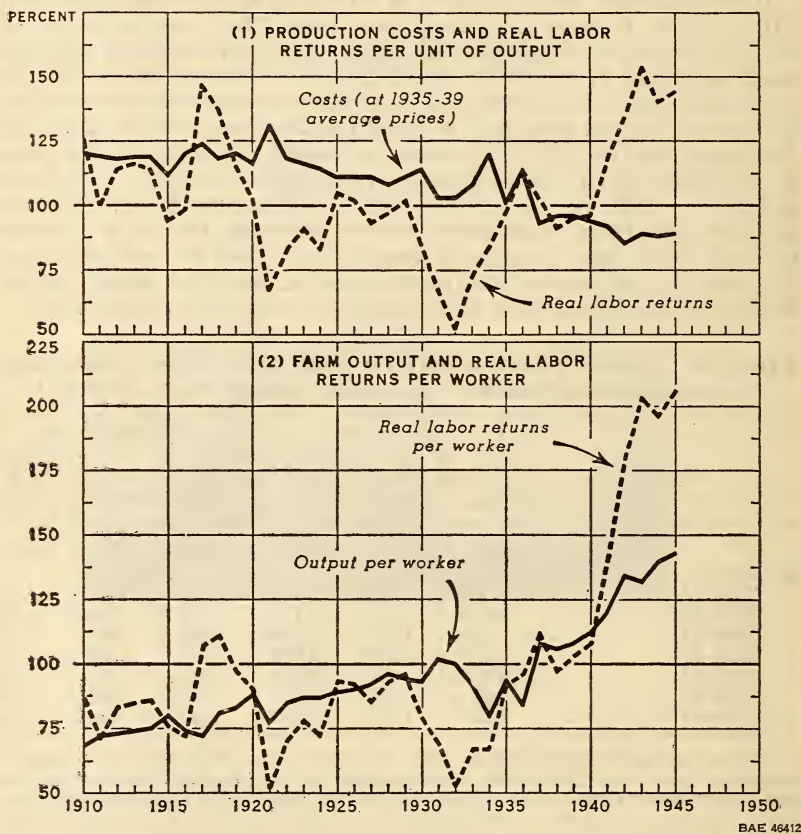
FIGURE 17—PRODUCTION COSTS AND REAL RETURNS TO FARM LABOR, UNITED STATES, 1910-45.
(INDEX NUMBERS, 1935-39=100)

Farmers' gains through more production efficiency have been overshadowed by changes in living costs as well as by changes in prices of items used in farm production. Over the long run there is a fairly close relationship between output per worker and real labor return per worker.

Land rent per acre is inclined to fluctuate with changes in the price level of farm products. In 1932, tenants were paying farm owners a net return per acre of only 3.3 percent on land values. Land values were 107 percent of the 1935–39 average (see table 54 in the appendix). In 1944, on the other hand, farm owners were getting a net return of 9.5 percent on farm real estate that was valued at 138 percent of the

1935–39 average. Net rent per acre in 1932 was 46 percent, and in 1944, 264 percent of the average of the base period.

Different groups among farm workers are affected somewhat differently by price fluctuations. As indicated previously, net hourly returns to labor favor operators and family workers in periods of high prices, and favor hired workers in periods of low prices. Land owners, generally, charge high rents in relation to the value of the farm in periods of prosperity, but tenants are better able to pay high rents then than to pay low rents when prices for farm products are low.

It might be supposed that "real labor returns" [11] per unit of output would be more closely related to the trend in production efficiency than are actual returns to labor. This may be true at certain times, but in general, real labor returns per unit are subject to about the same wide fluctuations as are actual labor returns. Farmers' gains through increased production efficiency, as a group, have been overshadowed by changes in prices of living items as well as by changes in prices of production-cost factors (section 1, fig. 17). During only 7 years out of the 21 years between the wars, 1919–39, were real labor returns per unit of output as good as, or better than, the average return during 1935–39.

The immense increase in output per worker of more than 100 percent during the third of a century, 1910–45, has brought an upward trend in real labor return per worker, especially since the depression of the 1930's and during World War II. This trend has been greatly accelerated at times, and retarded at other times, by violent changes in prices of cost inputs and farm products and in the volume of farm output. These fluctuations stand out prominently in war and depression years (section 2, fig. 17).

The extent to which increases in real labor returns per farm worker have paralleled increases in yearly earnings of those who buy the farm products is another noteworthy question. A comparison of these factors is made here in terms of real yearly income to all farm labor including operator, family, and hired workers, and real wages per year of industrial workers employed in factories, railroading, and mining.

In terms of real dollar income, there is a marked difference during all of the 36-year period between the yearly amounts earned by farm labor and by industrial workers (section 1, fig. 18). It is not a purpose of this publication fully to analyze this difference. It seems sufficient for the purpose intended merely to point out that the dollar earned by the farm worker and the dollar earned by the industrial worker are not comparable because of difference in real purchasing power at any one point of time. A dollar will buy more rent on the farm than it will buy in the city; more food at farm prices than at retail city prices; more heat that comes from farm-produced wood than from coal or oil at city prices. No attempt is made here to indicate what an equitable ratio between dollar income of farm labor and of industrial workers should be. The real significance of the chart for the comparison intended is found in the difference in trends of real labor income for the two classes of workers (section 2, fig. 18).

[11] "Real labor returns" were calculated by deflating labor returns in current dollars by the index of prices paid by farmers for commodities used in living. The indexes in figure 17 are for all farm labor, including hired, operator, and family.

This comparison shows that real income per farm worker fluctuates somewhat more than does income per industrial worker. But the labor incomes of the two groups move in the same general direction, and there seems to be no indication that the general trend of one is stronger than the trend of the other. It seems perfectly clear that any benefits

*RETURNS TO LABOR PER FARM WORKER DEFLATED BY INDEX OF PRICES PAID BY FARMERS FOR COMMODITIES USED IN·LIVING (1935·39=100), AND AVERAGE ANNUAL WAGES PER INDUSTRIAL WORKER DEFLATED BY B.L.S. "COST-OF-LIVING INDEX (1935-39=100)". ADJUSTMENT OF INDUSTRIAL WORKERS' INCOME FOR UNEMPLOYMENT MADE·BY MULTIPLYING PERCENTAGE EMPLOYED IN LABOR FORCE BY UNADJUSTED INCOME PER WORKER.

FIGURE 18—REAL INCOME PER FARM WORKER AND PER INDUSTRIAL WORKER, UNITED STATES, 1910-45.

The marked difference between yearly labor returns of farm workers and of industrial workers is partially offset by cheaper farm items, as food, rent, and fuel. Although real labor returns of farm workers fluctuate more than those of industrial workers, the general trend is about the same for both groups.

received by farm workers in real yearly labor income have been matched by increased real wages of industrial workers. Reductions in production costs of farm products through increased farm efficiency have not increased the returns to agricultural workers any more than wages to industrial workers have been increased. Both groups have been affected by the same set of general economic conditions.

ANOTHER 30 YEARS OF MECHANIZATION

In a way, the most important result of technological developments in agriculture has been the great increase in production of food and fiber for human use. Mechanization was merely an important aid to this end, made possible by a growing Nation that had relatively great resources and dynamic initiative. A growing urban industry that took from the land millions of persons and ever-growing supplies of agricultural products, and at the same time manufactured more and more tractors and other labor-saving machines for farmers, was a motivating influence back of agricultural developments. Agricultural research and education by Federal and State Governments has had great influence. The fact that fewer people were needed in agriculture was merely incidental in the general scheme of development. The fact that industry could get most of its additional workers from the farms was most fortunate in the affairs of a growing Nation.

Two outstanding developments—the switch from animal power to mechanical power, and the increased production per acre and per animal—have made possible large quantities of foods of a wide variety for a growing Nation. At times there appeared to be too much food and fiber because, low priced though it was, people at home and abroad could not buy all they wanted. But at no time, even in the two great war emergencies that have come within the farming experience of many present-day farmers, has there been any real scarcity of either. At no time have our farmers failed to produce abundantly for use at home, and at times to produce something in addition for the hungry people of other Nations.

A recent estimate [12] places the probable population of the United States at 162 million in 1975, compared with an average of 135 million in the war years, 1940–44, and 141 million in 1946. On the basis of this population forecast there will be 21 million more people in our Nation to be fed and clothed, about 30 years from now. If each person is to be fed and clothed at that time as well as the average person was fed and clothed in 1940–44, additional production from an equivalent of 53 million high-yielding crop acres would be necessary. This estimate assumes a continuation of the high production per acre of the war period, and that the same number of acres as were used in 1940–44 (24 million) will be used for products for export (table 34). This does not mean, of course, that additional *new* acreages must be found. Increases in crop yields and in livestock production per animal are probable. Undoubtedly, horses and mules will be much fewer than now, and fewer acres will be needed for their feed, thus releasing cropland for human purposes.

Some idea of the importance of this released acreage for the production of food and fiber can be had by the simple assumption that numbers of horses and mules on farms will continue to decrease at about the same rate as in recent years. On this basis there would be on farms in 1975 only about 4 million head of horses and mules of all ages, compared with about 11 million head in 1946. This would release 27 million average acres between 1940–44 and 1975.

[12] Bureau of the Census. Series P-46, No. 7. Population-Special Reports. Sept. 15, 1946

TABLE 34.—*Crop acreages needed to produce food, fiber, and tobacco for domestic consumption in 1955 and 1975, under assumed conditions of mechanization, production, and consumption*

Item	Unit	1940–44 average	Assuming 1935–39 yields and per capita consumption [1]		Assuming 1940–44 yields and per capita consumption [1]	
			1955	1975	1955	1975
Number of horses and mules on farms, January 1 [2]	Millions	13.6	7.5	4.0	7.5	4.0
Number of tractors on farms, January 1 [3]	..do..	1.9	3.5	5.0	3.5	5.0
Acres of crops harvested for:						
Export products	..do..	24	24	24	24	24
Feed for horses and mules in cities	..do..	1	1	1	1	1
Feed for horses and mules on farms	..do..	38	23	12	21	11
Abnormal military requirements [4]	..do..	22	....	....	....	....
Products for domestic consumption [4]	..do..	263	310	335	292	316
Total used or needed	..do..	348	358	372	338	352
Per capita consumption [4]	Acres	1.95	2.07	2.07	1.95	1.95
Production per acre of crops harvested [4]	Index, 1935–39 = 100	113	100	100	113	113
Total population [5]	Millions	135	150	162	150	162
Additional acreage required for domestic consumption	..do..	....	47	72	29	53
Acreage released by decline in horse and mule numbers	..do..	....	15	26	17	27
Acreage released by elimination of abnormal military requirements	..do..	....	22	22	22	22
Net additional acreage needed	..do..	....	10	24	−10	4

[1] Acreage required for export products and for feeding horses and mules in cities assumed to remain at 1940–44 average levels.

[2] Horse and mule numbers in 1955 and 1975, assuming a continuation of the recent downward trend in colt crops, and continuation of horse and mule mortality rates of recent years.

[3] Tractor numbers in 1955 and 1975 needed because of the assumed disappearance of work stock (horses and mules over 3 years old). Average displacement of around 4 head of work stock per tractor was assumed to average around 3 between 1944 and 1955, and around 2 between 1955 and 1975. Estimates of tractors in 1955 and 1975 do not include allowance for expected further increase in garden tractors on farms. There were only about 50 thousand of them in 1944.

[4] So far as can be determined our civilian population consumed an average of 7 to 8 percent more farm products during 1940–44 than during 1935–39. This greater per capita consumption came from fewer acres per capita because of an increase in yields per acre of 13 percent. In addition, the military forces took the same quantity per capita plus the products from about 22 million acres of land. (See discussion beginning on p. 25). The average per capita consumption of 1.95 acres in 1940–44 multiplied by the total population (including military) of 135 million equals 263 million acres. The domestic consumption of 263 million acres in 1940–44 thus includes civilian consumption and military personnel consumption at civilian rates.

[5] Population year beginning July 1. Forecasts for 1955 and 1975 taken from Bureau of the Census, Series P-46, No. 7, Population-Special Reports, Sept. 15, 1946.

By 1975 an additional 22 million crop acres should be available that were used in 1940–44 for the production of military supplies over and above the high per capita rate of consumption of our civilian and military population. (See footnote 4, table 34). Production of 49 million acres from these two sources would nearly take care of food and fiber requirements for the increased population, at the high consumption rates of 1940–44. Additional production equivalent to that from only 4 million acres would be needed. There are so many possibilities in such a situation that 4 million acres, more or less, is not a significant part of the total. The range in the total crop acreage harvested from time to time is much greater than this. Additional drainage of lands now being farmed could more than make up for this difference. A little better farming all around could easily make up for it and accelerated adoption of improved practices would throw the balance in the other direction.

The important question is whether farmers will be able during the next farming generation to produce at the high wartime level and yet conserve their lands so that 30 years hence the acreage in crops will be as large and as productive as in 1940–44. In the opinion of the authors this will not be difficult. Continuation of a national policy of soil conservation and better farming methods, with technological progress that leads to more production per acre and per animal, may be expected. Increased adoption of improved production techniques could lead to surplus production, requiring expanded markets for disposal. Experience of the last 25 years points strongly in this direction.

With the above assumptions of 1940–44 average production per acre and per animal, and even with a continuation of the high wartime level of per capita consumption, farm surpluses are likely to pile up long before 1975, unless markets are expanded. By 1955, about 17 million crop acres that were used to produce horse and mule feed during the war would be released for other production. This acreage, plus the 22 million acres that were used to produce extra war supplies, would make an additional 39 million crop acres available for production for human use, whereas only 29 million acres will be required under the assumptions used for the expected increase in population (table 34).

There are, of course, two sides to all questions. If it is assumed that farmers' average level of production per acre and per animal would be like that of 1935–39, instead of the high level of 1940–44, 72 million additional crop acres would be needed in 1975 to supply each person with the average per capita rate of consumption that prevailed in 1935–39. The assumed disappearance of horses and mules would make available 26 million acres and this, plus the 22 million acres used to produce extra war supplies, would account for 48 of the required 72 million acres. Production equivalent to that of 24 million average acres in 1935–39 would have to come from other sources. Therefore the problem under these assumed conditions would be one of increased production rather than one of expanded markets.

If the need for more farm products develops, however, several ways will be available to farmers for increasing production without more land, as witnessed by their performance in World War II. Under assumptions of prewar yields and per capita consumption, additional

production from 10 million 1935–39 acres would be needed by the increased population about 1955.

These assumptions and observations apply to agriculture in general. Production of many crops in the United States can be expanded tremendously by the use of small acreages. Fruit, vineyard, and nut crops as a whole used less than 5 million acres in 1944. All truck crops for processing and fresh consumption used a little more than 4 million acres. Irish potatoes were grown on only 3 million acres in 1944. Thus, production of these important crops took only about 12 million acres, or less than 5 percent of the total crop acreage in 1944. Production of these crops can be expanded greatly by using relatively little additional land.

Any increased domestic needs for such cash crops as cotton and wheat could be met by using lands suitable for their growth. Increased cotton acreages could come largely from acres now used to grow feed crops, and wheat-acreage expansion could be mainly on lands now used for pasture and feed crops. The tremendous wartime expansion of soybeans and peanuts was principally at the expense of feed crops in the Corn Belt in the first instance, and at the expense of feed crops and cotton in the second instance. It probably will be easy at any time in the next 30 years to divert enough suitable land to any of the chief cash-crop enterprises to over-supply the domestic markets. Once our requirements for direct food, fiber, and tobacco crops are met, the remainder of our agricultural resources would become available for feed production to be converted into meat animals and animal products. Great possibilities are ahead for increasing feed production through improvement of pastures and hay crops, and for increased production of some grain crops, especially in parts of the South.

Assumptions regarding future horse and mule numbers have a decided effect on forecasts of farm mechanization. In recent years, one farm tractor has been added to the numbers on farms for approximately each 4 head of work stock that disappear. This ratio of work-stock disappearance to tractors added is bound to decrease as tractors and tractor equipment for small farms become increasingly available, and as thousands of farms acquire one or more additional tractors. For the purpose of the estimates used in this section it has been assumed that during the 10 years, 1945–55, the net disappearance of work stock would average 3 per additional tractor, and during the 20 years, 1955–75, one tractor would be added for each two work animals that disappear.

On the basis of the above assumptions, and the assumption that horse and mule numbers will continue to disappear from farms at about the same rate as in recent years, the tractors on farms in 1955 would number about 3.5 million, and in 1975, about 5.0 million. Suitable equipment for these power units will be developed, so that farming will become increasingly attractive from the standpoint of lessened physical effort.

Mechanical cotton pickers are a present-day development of keen interest. The next generation may see their successful development, and witness widespread adoption in some cotton areas. Many people believe that we are on the verge of rapid development of farm mechanization in southern agriculture. The effects of such a development

on farm workers and on the pattern of agriculture during the next generation may be enormous. In other parts of the country such recently developed machines as beet harvesters, sweet-corn pickers, pick-up balers, forage choppers, manure loaders, dairy-barn cleaners, flame cultivators, and machines for removing silage, as well as further improvement and more widespread adoption of older labor-saving machines are now on the horizon.

Further farm mechanization in the United States will mean that fewer people will be needed for farm work, but of equal importance is the possibility of less need for overworking at rush seasons and for women and children working in the fields. Something resembling complete electric service for farmers seems assured and this will help to reduce the long hours and tiresome jobs in the homes as well as on the farms.

Obviously, the conclusions reached in this section of this publication are contingent to a large extent on the assumptions covering further disappearance of horses and mules from farms. About the best that can be said of these assumptions is that they seem reasonable and logical. If horse and mule numbers are reduced slower or faster than here indicated, the periods indicated by the dates used will be lengthened or shortened. The stage is definitely set for continued mechanization. New labor-saving power units and machines will be adopted most rapidly if we have satisfactory economic conditions. New machines and new ideas will be brought out for trial, and many of these will be adopted during the coming farming generation, just as the past generation adopted new practices and new techniques.

The evidence developed in this publication seems to point conclusively to the fact that a very large part of the increased efficiency in agricultural production in the past, or the increase in output per unit of input, has been caused principally by increased production per acre and per animal rather than by decreased total physical expenditures. Initial savings in labor and other costs of producing farm-animal power have been used to produce more milk, more pork, and more of other livestock products for the market. Labor saved because of greater speed in doing farm jobs by the use of modern machines has not always meant the release of farm workers. Rather, the large volume of business developed through the introduction of more intensive enterprises, and through more production per acre and per animal, has absorbed much of the labor that would have been released because of mechanization.

Further increases in efficiency of farm production are desirable and will continue. If past patterns continue in the future march of farm technology, increases in efficiency will be closely related to increases in total volume of farm output.

Production efficiency and the relationships between prices that farmers receive and the prices they pay will continue to be dominant factors in determining the economic welfare of farm people. Expanded markets for farm products must accompany increases in production efficiency if both producers and consumers are to benefit to the fullest extent.

APPENDIX

The following tables contain data used in the charts shown in this report, and other supplementary information.

TABLE 35.—*Index numbers of total volume of farm power and machinery and equipment, farm output, and total farm employment, United States, 1870–1946* [1] [2]

[Volume in terms of 1935–39 average dollars; 1870 = 100]

Year	Farm power machinery and equipment	Farm output	Farm employment	Year	Farm power machinery and equipment	Farm output	Farm employment
1870.....	100	100	100	1927....	463	326	157
1880.....	163	156	125	1928....	463	337	158
1890.....	232	183	146	1929....	466	334	158
1900.....	295	240	159	1930....	471	324	156
1910.....	385	260	169	1931....	468	355	156
1911.....	395	271	168	1932....	452	347	154
1912.....	404	274	168	1933....	416	318	154
1913.....	416	279	168	1934....	391	269	151
1914.....	429	284	168	1935....	389	326	155
1915.....	430	303	167	1936....	391	292	154
1916.....	431	277	168	1937....	403	371	152
1917.....	420	269	165	1938....	419	360	151
1918.....	422	290	158	1939....	428	365	150
1919.....	468	295	155	1940....	434	373	148
1920.....	477	313	159	1941....	445	389	145
1921.....	505	279	159	1942....	466	433	145
1922.....	496	305	160	1943....	487	425	143
1923.....	454	308	159	1944....	494	446	140
1924.....	455	308	159	1945....	517	440	137
1925.....	458	318	160	1946....	542	453	140
1926.....	460	326	161				

[1] See footnotes table 4 for sources of data.
[2] Data used in figure 1 derived from this table.

TABLE 36.—*Index numbers of production per worker in agriculture and industry, United States, 1910–45* [1]

[1935–39 = 100]

Year	Gross farm production per farm worker	Production per worker in manufacturing and mining	Year	Gross farm production per farm worker	Production per worker in manufacturing and mining
1910....	77	62	1929...	98	101
1911....	80	59			
1912....	82	66	1930...	96	95
1913....	83	68	1931...	103	92
1914....	85	64	1932...	101	85
1915....	89	69	1933...	94	91
1916....	84	69	1934...	83	85
1917....	83	66	1935...	95	93
1918....	91	64	1936...	86	102
1919....	94	65	1937...	107	102
			1938...	105	95
1920....	97	68	1939...	107	108
1921....	87	67			
1922....	92	78	1940...	110	115
1923....	94	81	1941...	117	122
1924....	93	81	1942...	128	130
1925....	94	87	1943...	127	138
1926....	95	90	1944...	135	143
1927....	97	92	1945...	137	142
1928....	99	96			

[1] Data used in figure 2 derived from this table.

TABLE 37.—*Index numbers of animal units of breeding livestock and livestock production per breeding unit, United States, 1919–46* [1]

[1935–39 = 100]

Year	Animal units of breeding livestock	Livestock production per breeding unit	Year	Animal units of breeding livestock	Livestock production per breeding unit
1919....	105	80	1933...	112	95
			1934...	110	87
1920....	102	80	1935...	97	95
1921....	102	83	1936...	101	98
1922....	106	87	1937...	99	98
1923....	110	86	1938...	98	104
1924....	106	88	1939...	105	105
1925....	101	91			
1926....	100	95	1940...	108	103
1927....	103	95	1941...	107	110
1928....	102	96	1942...	117	111
1929....	101	98	1943...	130	109
			1944...	129	105
1930...	102	99	1945...	120	112
1931...	104	99	1946...	119	111
1932...	107	97			

[1] Includes all breeding livestock except horses, and all livestock production except farm-produced power of horses and mules.

TABLE 38.—*Index numbers of horse and mule numbers on farms, and volume of production of meat animals and animal products, United States, 1919–46* [1]

[1920–24 = 100]

Year	Horses and mules all ages	Product added by meat animals and animal products	Year	Horses and mules all ages	Product added by meat animals and animal products
1919....	108	95	1933...	71	118
			1934...	69	111
1920....	105	92	1935...	68	108
1921....	102	97	1936...	66	114
1922....	100	102	1937...	64	113
1923....	98	105	1938...	62	116
1924....	95	104	1939...	60	124
1925....	92	105			
1926....	90	107	1940...	59	125
1927....	86	109	1941...	57	133
1928....	83	110	1942...	56	146
1929....	80	111	1943...	54	157
			1944...	51	155
1930....	78	114	1945...	49	156
1931....	75	116	1946...	45	149
1932....	73	116			

[1] Data used in figure 3 derived from this table.

TABLE 39.—*Inventory values of horses and mules and farm machinery, United States, January 1, 1910–46* [1]

[Values in current dollars]

Year	Horses and mules [2]	Tractors	Motor-trucks	Auto-mobiles	Other farm machinery	Total
	Million dollars	*Million dollars*	*Million dollars*	*Million dollars*	*Million dollars*	*Million dollars*
1910........	2,790	2	0	25	1,238	4,055
1911........	2,957	6	1	53	1,261	4,278
1912........	2,872	10	3	85	1,284	4,254
1913........	3,039	16	4	111	1,328	4,498
1914........	3,080	21	5	133	1,369	4,608
1915........	2,936	30	10	189	1,377	4,542
1916........	2,912	42	18	291	1,392	4,655
1917........	2,985	49	23	356	1,424	4,837
1918........	3,104	66	31	520	1,663	5,384
1919........	3,043	180	43	628	2,151	6,045
1920........	3,072	283	67	1,005	2,240	6,667
1921........	2,553	358	103	1,009	2,423	6,446
1922........	2,051	347	92	687	2,078	5,255
1923........	1,962	263	96	654	1,671	4,646
1924........	1,814	285	101	751	1,680	4,631
1925........	1,724	287	115	705	1,663	4,494
1926........	1,683	330	139	791	1,612	4,555
1927........	1,552	362	171	855	1,617	4,557
1928........	1,565	403	186	783	1,628	4,565
1929........	1,575	416	222	857	1,621	4,691
1930........	1,539	461	244	963	1,634	4,841
1931........	1,276	488	213	829	1,615	4,421
1932........	1,078	437	190	756	1,479	3,940
1933........	1,038	360	159	642	1,235	3,434
1934........	1,269	296	152	600	1,067	3,384
1935........	1,451	294	160	698	1,001	3,604
1936........	1,736	361	164	758	1,023	4,042
1937........	1,762	452	186	814	1,107	4,321
1938........	1,581	568	220	906	1,262	4,537
1939........	1,446	604	230	924	1,367	4,571
1940........	1,328	589	238	944	1,364	4,463
1941........	1,170	636	257	912	1,421	4,396
1942........	1,102	808	300	1,015	1,625	4,850
1943........	1,295	1,038	425	987	2,059	5,804
1944........	1,286	1,152	570	1,091	2,566	6,665
1945........	1,078	1,330	631	1,088	3,186	7,313
1946........	942	1,316	586	922	3,433	7,199

[1] Data used in figure 4 derived from this table.
[2] Includes harness.

TABLE 40.—*Inventory values of farm horses and mules, and farm machinery, United States, January 1, 1910–46* [1]

[Values in 1935–39 average dollars]

Year	Horses and mules [2]	Tractors	Motor-trucks	Auto-mobiles	Other farm machinery	Total
	Million dollars	*Million dollars*	*Million dollars*	*Million dollars*	*Million dollars*	*Million dollars*
1910.........	2,564	1	0	13	1,876	4,454
1911.........	2,631	2	1	26	1,911	4,571
1912.........	2,679	4	1	46	1,945	4,675
1913.........	2,719	7	3	67	2,012	4,808
1914.........	2,787	8	4	89	2,074	4,962
1915.........	2,813	12	7	123	2,025	4,980
1916.........	2,787	18	12	179	1,989	4,985
1917.........	2,782	26	17	251	1,780	4,856
1918.........	2,788	42	26	391	1,630	4,877
1919.........	2,797	79	32	458	2,049	5,415
1920.........	2,748	123	40	558	2,055	5,524
1921.........	2,689	172	60	619	2,308	5,848
1922.........	2,618	186	76	630	2,234	5,744
1923.........	2,542	214	92	681	1,723	5,252
1924.........	2,470	248	105	781	1,663	5,267
1925.........	2,386	274	133	854	1,647	5,294
1926.........	2,315	310	162	937	1,596	5,320
1927.........	2,228	346	192	993	1,601	5,360
1928.........	2,147	391	218	993	1,612	5,361
1929.........	2,079	414	244	1,032	1,621	5,390
1930.........	2,019	460	261	1,075	1,634	5,449
1931.........	1,953	498	267	1,060	1,631	5,409
1932.........	1,873	511	264	987	1,590	5,225
1933.........	1,807	510	251	884	1,357	4,809
1934.........	1,756	508	254	884	1,123	4,525
1935.........	1,728	524	258	947	1,043	4,500
1936.........	1,680	562	268	971	1,044	4,525
1937.........	1,636	616	287	1,030	1,096	4,665
1938.........	1,579	684	302	1,068	1,214	4,847
1939.........	1,536	724	296	1,048	1,353	4,957
1940.........	1,503	772	304	1,077	1,364	5,020
1941.........	1,464	838	318	1,089	1,434	5,143
1942.........	1,417	945	336	1,114	1,578	5,390
1943.........	1,378	1,050	371	1,086	1,746	5,631
1944.........	1,319	1,105	397	1,071	1,820	5,712
1945.........	1,257	1,212	423	1,066	2,025	5,983
1946.........	1,168	1,292	450	1,066	2,296	6,272

[1] Data used in figure 5 derived from this table.
[2] Includes harness.

TABLE 41.—*Horses and mules, and tractors on farms, United States, January 1, 1910–47* [1]

Year	Horses and mules	Tractors	Year	Horses and mules	Tractors
	Thousands	*Thousands*		*Thousands*	*Thousands*
1910	24,211	1	1930	19,124	920
1911	24,847	4	1931	18,468	997
1912	25,277	8	1932	17,812	1,022
1913	25,691	14	1933	17,337	1,019
1914	26,178	17	1934	16,997	1,016
1915	26,493	25	1935	16,683	1,048
1916	26,534	37	1936	16,226	1,125
1917	26,659	51	1937	15,802	1,230
1918	26,723	85	1938	15,245	1,370
1919	26,490	158	1939	14,792	1,445
1920	25,742	246	1940	14,478	1,545
1921	25,137	343	1941	14,104	1,675
1922	24,588	372	1942	13,655	1,890
1923	24,018	428	1943	13,231	2,100
1924	23,285	496	1944	12,613	2,210
1925	22,569	549	1945	11,950	2,425
1926	21,986	621	1946	11,063	2,585
1927	21,192	693	1947	10,024	2,700
1928	20,448	782			
1929	19,744	827			

[1] Data used in figure 6 derived from this table.

TABLE 42.—*Tractors: Number on farms by geographic divisions and United States, 1920, 1930, 1940, and 1945* [1] [2]

Year	New England	Middle Atlantic	East North Central	West North Central	South Atlantic	East South Central	West South Central	Mountain	Pacific	United States
	Thousands	*Thousands*	*Thousands*	*Thousands*	*Thousands*	*Thousands*	*Thousands*	*Thousands*	*Thousands*	*Thousands*
1920	2	14	58	98	11	5	20	18	20	246
1930	14	82	249	318	47	25	74	48	63	920
1940	28	125	431	531	62	41	163	74	90	1,545
1945	54	206	644	759	135	87	277	120	140	2,422

[1] From reports of the Census of Agriculture.
[2] Data used in figure 7 derived from this table.

TABLE 43.—*Breaking land:* [1] *Percentage broken with tractor-drawn implements, by States, 1939* [2]

State	Acreage broken with tractor power	State	Acreage broken with tractor power
	Percent		*Percent*
Maine	28	North Carolina	15
New Hampshire	47	South Carolina	14
Vermont	26	Georgia	7
Massachusetts	51	Florida	19
Rhode Island	60		
Connecticut	50	Kentucky	17
		Tennessee	13
New York	54	Alabama	10
New Jersey	69	Mississippi	17
Pennsylvania	43		
		Arkansas	17
Ohio	63	Louisiana	38
Indiana	69	Oklahoma	70
Illinois	80	Texas	72
Michigan	53		
Wisconsin	56	Montana	84
		Idaho	51
Minnesota	72	Wyoming	72
Iowa	82	Colorado	75
Missouri	50	New Mexico	64
North Dakota	79	Arizona	88
South Dakota	80	Utah	50
Nebraska	76	Nevada	61
Kansas	88		
Delaware	55	Washington	78
Maryland	36	Oregon	68
Virginia	15	California	88
West Virginia	11		

[1] Breaking land includes plowing, listing, bedding, and middlebusting. State averages were computed from county data used in making figure 8.

[2] A. P. Brodell. Machine and Hand Methods in Crop Production. F.M. 18, p. 6. Revised January 1942. Processed.

Table 44.—*Value of horses and mules, tractors, motortrucks, auto-mobiles, and other farm machinery, per acre of cropland, by geographic divisions, 1910, 1920, 1930, 1940–45* [1]

[Values in 1935–39 average dollars]

NEW ENGLAND

Item	1910	1920	1930	1940	1941	1942	1943	1944	1945
	Dollars	Dollars	Dollars	Dollars	Dollars	Dollars	Dollars	Dollars	Dollars
Other machinery..	15.85	13.32	14.40	8.85	9.42	10.23	11.49	11.81	13.46
Automobiles.....	.05	2.60	6.03	7.28	7.29	7.43	7.34	7.14	9.14
Motortrucks.....	......	.51	2.87	4.06	4.21	4.40	4.91	5.27	5.96
Tractors.........	......	.17	1.43	3.14	3.35	3.75	4.30	4.51	5.06
Horses and mules.	12.00	11.04	8.38	5.94	5.73	5.44	5.45	5.29	5.13
Total.....	27.90	27.64	33.11	29.27	30.00	31.25	33.49	34.02	38.75

MIDDLE ATLANTIC

Item	1910	1920	1930	1940	1941	1942	1943	1944	1945
Other machinery..	13.64	13.17	14.73	11.43	12.00	13.21	14.95	14.59	17.00
Automobiles.....	.05	2.40	5.68	6.04	6.10	6.25	6.22	5.74	6.36
Motortrucks.....	......	.35	2.43	2.45	2.56	2.72	3.06	3.08	3.12
Tractors.........	......	.34	2.50	4.00	4.33	4.74	5.49	5.45	6.26
Horses and mules.	10.47	9.98	7.82	6.78	6.64	6.39	6.28	5.61	5.56
Total......	24.16	26.24	33.16	30.70	31.63	33.31	36.00	34.47	38.30

EAST NORTH CENTRAL

Item	1910	1920	1930	1940	1941	1942	1943	1944	1945
Other machinery..	6.36	6.44	4.33	5.39	5.61	6.09	6.64	6.78	7.39
Automobiles.....	.05	2.21	3.93	4.52	4.52	4.55	4.38	4.23	3.99
Motortrucks.....	......	.12	.99	.98	1.01	1.06.	1.15	1.21	1.13
Tractors.........	......	.41	2.00	3.56	3.80	4.23	4.64	4.75	5.10
Horses and mules.	8.08	7.57	5.65	4.54	4.26	3.91	3.61	3.25	3.01
Total......	14.49	16.75	16.90	18.99	19.20	19.84	20.42	20.22	20.62

WEST NORTH CENTRAL

Item	1910	1920	1930	1940	1941	1942	1943	1944	1945
Other machinery..	4.56	4.87	4.29	2.98	3.12	3.42	3.62	3.79	4.24
Automobiles.....	.04	1.36	1.92	2.03	2.05	2.10	1.96	1.94	1.83
Motortrucks.....	......	.07	.36	.43	.45	.48	.50	.54	.60
Tractors.........	......	.38	1.16	2.11	2.28	2.55	2.69	2.83	3.12
Horses and mules.	5.51	5.32	3.62	2.54	2.49	2.41	2.24	2.11	2.01
Total......	10.11	12.00	11.35	10.09	10.39	10.96	11.01	11.21	11.80

SOUTH ATLANTIC

Item	1910	1920	1930	1940	1941	1942	1943	1944	1945
Other machinery..	4.92	5.10	1.60	1.97	2.13	2.32	2.55	2.73	3.12
Automobiles.....	.04	1.68	4.46	4.21	4.37	4.39	4.25	4.32	5.13
Motortrucks.....	......	.15	.98	1.17	1.25	1.30	1.43	1.57	1.87
Tractors.........	......	.15	.71	.91	1.01	1.16	1.29	1.44	1.63
Horses and mules.	9.09	10.00	8.33	7.34	7.44	7.25	7.06	7.15	6.97
Total......	14.05	17.08	16.08	15.60	16.20	16.42	16.58	17.21	18.72

EAST SOUTH CENTRAL

Item	1910	1920	1930	1940	1941	1942	1943	1944	1945
Other machinery..	4.24	4.46	2.15	2.59	2.75	2.97	3.24	3.52	4.01
Automobiles.....	.02	.85	3.36	2.87	2.93	2.92	2.81	2.88	3.19
Motortrucks.....	......	.06	.50	.80	.84	.87	.95	1.05	1.21
Tractors.........	......	.09	.45	.74	.82	.92	1.01	1.14	1.28
Horses and mules.	9.12	10.15	8.22	7.55	7.51	7.36	7.13	7.31	7.08
Total......	13.38	15.61	14.68	14.55	14.85	15.04	15.14	15.90	16.77

TABLE 44.—*Value of horses and mules, tractors, motortrucks, automobiles, and other farm machinery, per acre of cropland, by geographic divisions, 1910, 1920, 1930, 1940–45* [1]—*Continued*

[Values in 1935–39 average dollars]

WEST SOUTH CENTRAL

Item	1910	1920	1930	1940	1941	1942	1943	1944	1945
	Dollars	Dollars	Dollars	Dollars	Dollars	Dollars	Dollars	Dollars	Dollars
Other machinery..	4.26	3.53	2.46	2.44	2.61	2.94	3.23	3.34	4.01
Automobiles.....	.03	.93	2.32	2.11	2.18	2.28	2.21	2.17	2.25
Motortrucks.....	......	.05	.47	.61	.65	.70	.77	.82	1.04
Tractors.........	......	.19	.62	1.41	1.56	1.87	2.09	2.19	2.58
Horses and mules.	7.23	6.42	4.90	3.56	3.52	3.44	3.33	3.16	3.22
Total......	11.52	11.12	10.77	10.13	10.52	11.23	11.63	11.68	13.10

MOUNTAIN

Item	1910	1920	1930	1940	1941	1942	1943	1944	1945
Other machinery..	6.60	4.86	4.56	3.58	3.61	3.94	4.22	4.43	5.12
Automobiles.....	.05	1.15	1.72	1.82	1.75	1.78	1.68	1.66	1.66
Motortrucks.....	......	.10	.59	.84	.84	.88	.94	1.01	1.26
Tractors.........	......	.44	.97	1.58	1.65	1.90	2.02	2.16	2.45
Horses and mules.	8.45	6.33	3.87	2.74	2.59	2.53	2.44	2.35	2.31
Total......	15.10	12.88	11.71	10.56	10.44	11.03	11.30	11.61	12.80

PACIFIC

Item	1910	1920	1930	1940	1941	1942	1943	1944	1945
Other machinery..	5.96	7.44	6.37	5.91	6.29	6.71	7.35	7.50	8.37
Automobiles.....	.05	1.83	3.44	3.91	3.98	3.95	3.81	3.68	3.90
Motortrucks.....	......	.20	1.10	1.60	1.70	1.74	1.90	1.99	2.28
Tractors.........	......	.69	2.13	2.79	3.18	3.36	3.66	3.82	4.20
Horses and mules.	6.21	5.86	3.47	2.43	2.36	2.21	2.10	1.90	1.80
Total......	12.22	16.02	16.51	16.64	17.51	17.97	18.82	18.89	20.55

UNITED STATES

Item	1910	1920	1930	1940	1941	1942	1943	1944	1945
Other machinery..	5.67	5.58	4.28	3.73	3.92	4.30	4.75	4.84	5.48
Automobiles.....	.04	1.51	2.82	2.94	2.98	3.03	2.96	2.85	2.93
Motortrucks.....	......	.11	.68	.83	.87	.92	1.01	1.06	1.17
Tractors.........	......	.33	1.20	2.11	2.29	2.57	2.86	2.94	3.28
Horses and mules.	7.33	6.99	5.01	3.95	3.86	3.72	3.60	3.36	3.24
Total......	13.04	14.52	13.99	13.56	13.92	14.54	15.18	15.05	16.10

[1] Based on data from reports of the Census of Agriculture.

TABLE 45.—*Value of products produced on farms reporting different types of power, by geographic divisions, 1939* [1][2]

Geographic division	Total value of products	Percentage of total value on farms reporting		
		Tractors	Horses and/or mules only	No horses, mules, or tractors
	Million dollars	*Percent*	*Percent*	*Percent*
New England.............	236.2	41.0	36.4	22.6
Middle Atlantic...........	587.2	56.4	33.0	10.6
East North Central........	1,483.8	65.7	28.7	5.6
West North Central........	1,830.7	68.5	27.0	4.5
South Atlantic............	915.8	21.1	64.1	14.8
East South Central........	609.7	15.5	66.0	18.5
West South Central........	959.6	39.3	51.4	9.3
Mountain.................	486.8	50.6	43.0	6.4
Pacific..................	703.8	57.0	23.2	19.8
United States.......	7,813.6	50.9	39.0	10.1

[1] See footnote 1, table 26.
[2] Data used in figure 9 derived from this table.

TABLE 46.—*Percentage of all farms receiving central-station electric service, United States, July 1, 1945* [1]

State	Percentage of farms receiving electric service	State	Percentage of farms receiving electric service
	Percent		*Percent*
Maine...................	56.1	West Virginia............	33.3
New Hampshire..........	73.7	North Carolina..........	37.0
Vermont................	59.4	South Carolina..........	37.3
Massachusetts...........	60.9	Georgia.................	34.0
Rhode Island............	81.8	Florida.................	35.6
Connecticut.............	84.4		
		Kentucky...............	27.0
New York...............	81.0	Tennessee...............	27.1
New Jersey..............	88.8	Alabama................	27.2
Pennsylvania............	66.4	Mississippi.............	20.6
Ohio...................	83.0	Arkansas................	20.4
Indiana.................	76.3	Louisiana...............	23.9
Illinois.................	60.1	Oklahoma...............	21.3
Michigan................	88.9	Texas...................	36.7
Wisconsin...............	69.8		
		Montana................	30.1
Minnesota...............	48.9	Idaho..................	82.2
Iowa...................	61.5	Wyoming...............	42.4
Missouri................	30.0	Colorado...............	52.8
North Dakota...........	9.0	New Mexico.............	24.9
South Dakota...........	12.1	Arizona................	62.9
Nebraska...............	33.2	Utah...................	76.0
Kansas.................	30.8	Nevada................	53.7
Delaware...............	56.6	Washington.............	82.9
Maryland...............	63.6	Oregon.................	77.8
Virginia................	34.3	California..............	87.7

[1] Based on data in reports of the Rural Electrification Administration, United States Department of Agriculture.

TABLE 47.—*Total production costs of farm power, machinery, and labor, United States, 1910–45* [1]

[Costs in 1935–39 average dollars]

Year	Total farm-produced power	Tractors	Trucks and auto-mobiles [2]	Other farm machinery	Farm labor [3]	Total
	Million dollars	*Million dollars*	*Million dollars*	*Million dollars*	*Million dollars*	*Million dollars*
1910........	1,535	2	10	781	2,999	5,327
1911........	1,584	5	21	796	3,048	5,454
1912........	1,623	8	30	821	3,074	5,556
1913........	1,662	10	41	834	3,073	5,620
1914........	1,705	13	53	844	3,114	5,729
1915........	1,735	22	80	818	3,190	5,845
1916........	1,752	32	127	788	3,057	5,756
1917........	1,768	50	173	726	3,063	5,780
1918........	1,687	70	199	670	3,154	5,780
1919........	1,781	112	231	828	3,145	6,097
1920........	1,727	155	259	832	3,233	6,206
1921........	1,681	145	302	852	3,023	6,003
1922........	1,638	171	315	830	3,096	6,050
1923........	1,596	163	357	679	3,135	5,930
1924........	1,544	179	417	656	3,078	5,874
1925........	1,491	186	463	649	3,119	5,908
1926........	1,448	211	520	635	3,138	5,952
1927........	1,394	236	559	637	3,132	5,958
1928........	1,342	254	589	646	3,162	5,993
1929........	1,293	286	626	654	3,151	6,010
1930........	1,251	310	635	649	3,101	5,946
1931........	1,207	297	589	617	3,163	5,873
1932........	1,163	269	542	589	3,136	5,699
1933........	1,132	258	508	511	3,059	5,468
1934........	1,109	256	512	440	2,857	5,174
1935........	1,091	294	550	443	3,042	5,420
1936........	1,063	323	586	459	2,921	5,352
1937........	1,040	381	600	495	3,083	5,599
1938........	1,006	412	591	528	3,006	5,543
1939........	978	455	628	570	3,022	5,653
1940........	956	509	623	575	3,015	5,678
1941........	933	571	647	621	3,061	5,833
1942........	905	638	676	689	3,155	6,063
1943........	872	677	697	747	3,126	6,119
1944........	832	751	718	807	3,161	6,269
1945........	789	807	747	897	3,070	6,310

[1] Data for figure 10 derived from this table.
[2] Includes only farm production share of automobile costs.
[3] Includes all farm labor costs except those for servicing and maintenance of machinery, trucks, automobiles, and tractors, and for the care and maintenance of and the growing of feed for horses and mules, which are included in the power and machinery cost items.

TABLE 48.—*Total production costs of farm power, machinery, and labor, United States, 1910–45* [1]

[Costs in current dollars]

Year	Total farm-produced power	Tractors	Trucks and automobiles [2]	Other farm machinery	Farm labor [3]	Total
	Million dollars	*Million dollars*	*Million dollars*	*Million dollars*	*Million dollars*	*Million dollars*
1910........	1,554	4	17	556	2,545	4,676
1911........	1,571	7	28	565	2,561	4,732
1912........	1,893	13	40	583	2,653	5,182
1913........	1,648	15	49	592	2,697	5,001
1914........	1,791	20	64	599	2,654	5,128
1915........	1,816	29	92	595	2,705	5,237
1916........	1,806	39	137	603	2,923	5,508
1917........	2,297	62	203	650	3,666	6,878
1918........	2,866	96	270	756	4,579	8,567
1919........	3,361	162	343	971	5,281	10,118
1920........	3,441	230	438	1,036	6,165	11,310
1921........	2,254	199	403	941	3,657	7,454
1922........	1,715	194	367	826	3,674	6,776
1923........	1,831	180	388	708	4,072	7,179
1924........	1,893	191	437	702	4,084	7,307
1925........	1,958	207	495	702	4,168	7,530
1926........	1,721	240	569	690	4,278	7,498
1927........	1,697	256	582	687	4,169	7,391
1928........	1,575	273	610	694	4,160	7,312
1929........	1,522	304	654	696	4,170	7,346
1930........	1,428	323	638	681	3,790	6,860
1931........	1,174	283	531	614	2,984	5,586
1932........	834	246	474	535	2,197	4,286
1933........	675	223	438	451	1,998	3,785
1934........	921	228	466	413	2,275	4,303
1935........	1,279	268	504	423	2,647	5,121
1936........	934	304	547	449	2,820	5,054
1937........	1,265	378	586	503	3,304	6,036
1938........	925	410	594	546	3,165	5,640
1939........	795	437	625	576	3,133	5,566
1940........	858	465	618	576	3,203	5,720
1941........	869	538	670	639	3,898	6,614
1942........	1,046	644	766	751	5,146	8,353
1943........	1,200	762	878	937	6,668	10,445
1944........	1,441	905	1,000	1,166	7,861	12,373
1945........	1,438	999	1,070	1,421	8,478	13,406

[1] Data for figure 11 derived from this table.
[2] Includes only farm production share of automobile costs.
[3] Includes all farm labor costs except those for servicing and maintenance of machinery, trucks, automobiles, and tractors, and for the care and maintenance of and the growing of feed for horses and mules, which are included in the power and machinery cost items.

TABLE 49.—*Index numbers of total production costs and costs per unit of farm output for farm power, machinery, and labor, United States, 1910–45 [1] (costs in 1935–39 average dollars)*

[1935–39=100]

Year	Farm-produced power		Tractors		Trucks and automobiles [2]		Other machinery		All power and machinery		All farm labor, power, and machinery	
	Total cost	Cost per unit of farm output	Total cost	Cost per unit of farm output	Total cost	Cost per unit of farm output	Total cost	Cost per unit of farm output	Total cost	Cost per unit of farm output	Total cost	Cost per unit of farm output
1910	148	195	1	1	2	3	157	207	93	122	97	128
1911	153	194	1	1	4	5	160	203	96	122	99	125
1912	157	196	2	2	5	6	165	206	99	124	101	126
1913	161	199	3	4	7	9	167	206	102	126	102	126
1914	165	199	3	4	9	11	169	204	105	127	104	125
1915	168	191	6	7	14	16	164	186	106	120	106	120
1916	169	209	9	11	21	26	158	195	108	133	104	128
1917	171	219	13	17	29	37	145	186	109	140	105	135
1918	163	194	19	23	34	40	134	160	105	125	105	125
1919	172	202	30	35	39	46	166	195	118	139	111	131
1920	167	182	42	46	44	48	167	182	119	129	113	123
1921	162	200	39	48	51	63	171	211	119	147	109	135
1922	158	178	46	52	53	60	166	187	118	133	110	124
1923	154	171	44	49	60	67	136	151	112	124	108	120
1924	149	166	48	53	71	79	131	146	112	124	107	119
1925	144	155	50	54	78	84	130	140	112	120	107	115
1926	140	147	57	60	88	93	127	134	113	119	108	114
1927	135	142	63	66	95	100	128	135	113	119	108	114
1928	130	131	68	69	100	101	129	130	113	114	109	110
1929	125	129	77	79	106	109	131	135	114	118	109	112

Year												
1930	121	127	83	87	107	113	130	137	114	120	108	114
1931	117	112	80	77	100	96	124	119	108	104	107	103
1932	112	111	72	71	92	91	118	117	103	102	103	102
1933	109	117	69	74	86	92	102	110	96	103	99	106
1934	107	135	69	87	87	110	88	111	93	118	94	119
1935	105	108	79	83	93	96	89	92	95	98	98	102
1936	103	120	87	102	99	115	92	108	97	113	97	114
1937	100	92	102	95	102	94	99	92	101	93	102	94
1938	97	91	110	105	100	95	106	101	102	97	101	95
1939	95	89	122	115	106	100	114	107	105	99	102	95
1940	92	84	136	125	105	96	115	106	107	98	103	94
1941	90	79	153	134	109	96	124	109	111	97	106	93
1942	87	69	171	135	114	90	138	109	116	91	110	87
1943	84	68	182	147	118	95	150	121	120	97	111	90
1944	80	62	201	156	121	94	162	126	124	96	114	88
1945	76	59	216	167	126	98	180	140	130	101	114	88

[1] Data used in figure 12 derived from this table.
[2] Includes only farm production share of automobile costs.

TABLE 56.—Index numbers of total production costs and costs per unit of farm output for farm power, machinery, and labor, United States, 1910–45 [1] (costs in current dollars)

[1935–39 = 100]

Year	Farm-produced power		Tractors		Trucks and automobiles [2]		Other machinery		All power and machinery		All farm labor, power, and machinery	
	Total cost	Cost per unit of farm output	Total cost	Cost per unit of farm output	Total cost	Cost per unit of farm output	Total cost	Cost per unit of farm output	Total cost	Cost per unit of farm output	Total cost	Cost per unit of farm output
1910	150	197	1	1	3	4	111	146	86	113	85	112
1911	151	191	2	3	5	6	113	143	88	111	86	109
1912	183	229	4	5	7	9	117	146	102	128	95	119
1913	159	196	4	5	9	11	119	147	93	115	91	112
1914	173	208	6	7	11	13	120	145	100	120	94	113
1915	175	199	8	9	16	18	119	135	103	117	96	109
1916	174	215	11	14	24	30	121	149	105	130	100	123
1917	221	283	17	22	36	46	130	167	130	167	125	160
1918	277	330	27	32	47	56	152	181	161	192	156	186
1919	324	381	45	53	60	71	195	229	196	231	185	218
1920	332	361	64	70	77	84	208	226	208	226	206	224
1921	217	268	55	68	71	88	189	233	154	190	136	168
1922	165	185	54	61	64	72	166	187	126	142	124	139
1923	176	196	50	56	68	76	142	158	126	140	131	146
1924	182	202	53	59	77	86	141	157	130	144	133	148
1925	189	203	58	62	87	94	141	152	136	146	137	147
1926	166	175	67	71	100	105	138	145	130	137	137	144
1927	163	172	71	75	102	107	138	145	130	137	135	142
1928	152	154	76	77	107	108	139	140	128	129	133	134
1929	146	151	85	88	115	119	139	143	129	133	134	138

Year												
1930	137	144	90	95	112	118	136	143	124	131	125	132
1931	113	109	79	76	93	89	123	118	105	101	102	98
1932	80	79	69	68	83	82	107	106	85	84	78	77
1933	65	70	62	67	77	83	90	97	72	77	69	74
1934	89	113	64	81	82	104	83	105	82	104	78	99
1935	123	128	75	79	88	91	85	89	100	104	93	97
1936	90	105	84	99	96	112	90	106	90	106	92	108
1937	122	112	105	98	103	95	101	93	111	102	110	101
1938	89	84	114	109	104	99	109	104	100	95	103	98
1939	76	71	122	115	109	103	115	108	99	93	102	96
1940	82	75	130	119	108	99	115	106	102	94	104	95
1941	83	73	150	132	117	103	128	112	110	96	121	106
1942	100	79	179	141	134	106	151	119	130	102	152	120
1943	115	93	212	171	154	124	188	152	153	123	190	153
1944	138	107	252	195	175	136	234	181	183	142	226	175
1945	138	107	278	216	187	145	285	221	200	155	245	190

[1] Data used in figure 13 derived from this table.
[2] Includes only farm production share of automobile costs.

TABLE 51.—*Index numbers of total production costs and costs per unit of farm output, United States, 1910–45* [1]

[1935–39 = 100]

Year	Production costs in 1935–39 average dollars		Production costs in current dollars	
	Total	Per unit of farm output	Total	Per unit of farm output
1910............	91	120	79	104
1911............	94	119	81	103
1912............	94	118	83	104
1913............	96	119	86	106
1914............	99	119	87	105
1915............	99	112	91	103
1916............	97	120	102	126
1917............	97	124	132	169
1918............	99	118	155	185
1919............	102	120	176	207
1920............	107	116	175	190
1921............	106	131	124	153
1922............	105	118	123	138
1923............	104	116	132	147
1924............	103	114	137	152
1925............	103	111	137	147
1926............	105	111	137	144
1927............	105	111	138	145
1928............	107	108	138	139
1929............	108	111	138	142
1930............	108	114	124	131
1931............	107	103	97	93
1932............	104	103	76	75
1933............	100	108	73	78
1934............	95	120	82	104
1935............	97	101	91	95
1936............	98	114	98	114
1937............	101	93	106	98
1938............	101	96	102	97
1939............	103	96	103	96
1940............	103	94	105	96
1941............	105	92	126	111
1942............	108	85	160	126
1943............	110	89	193	156
1944............	113	88	217	168
1945............	115	89	228	177

[1] Data used in figure 14 derived from this table.

TABLE 52.—*Index numbers of price of cost factors, and of production costs and gross income per unit of output, United States, 1910–45* [1] [2]

[1935–39 = 100]

Year	Cost per unit of farm output in 1935–39 average dollars	Price of cost factors	Cost per unit of farm output in current dollars	Gross income per unit of farm output in current dollars
1910.............	120	87	104	96
1911.............	119	86	103	86
1912.............	118	88	104	92
1913.............	119	90	106	94
1914.............	119	88	105	95
1915.............	112	92	103	90
1916.............	120	105	126	111
1917.............	124	136	169	172
1918.............	118	157	185	185
1919.............	120	173	207	194
1920.............	116	164	190	167
1921.............	131	117	153	117
1922.............	118	117	138	118
1923.............	116	127	147	127
1924.............	114	133	152	127
1925.............	111	133	147	138
1926.............	111	130	144	134
1927.............	111	131	145	131
1928.............	108	129	139	130
1929.............	111	128	142	134
1930.............	114	115	131	115
1931.............	103	91	93	80
1932.............	103	73	75	62
1933.............	108	73	78	73
1934.............	120	86	104	95
1935.............	101	94	95	97
1936.............	114	100	114	115
1937.............	93	105	98	101
1938.............	96	101	97	92
1939.............	96	100	96	95
1940.............	94	102	96	94
1941.............	92	120	111	115
1942.............	85	148	126	141
1943.............	89	175	156	173
1944.............	88	191	168	171
1945.............	89	199	177	178

[1] See footnote 8, page 68 and footnote 9, page 69.
[2] Data used in figure 15 derived from this table.

TABLE 53.—*Returns to all farm labor and capital, and relative returns to family and hired labor, United States, 1910–45* [1]

Year	Returns to—					Hourly returns of family workers as a percent of returns to hired workers
	Land	Working capital	Hired workers	Operator and family workers	Total	
	Million dollars	*Million dollars*	*Million dollars*	*Million dollars*	*Million dollars*	*Percent*
1910...............	1,577	652	757	2,489	5,475	105
1911...............	1,633	669	760	1,923	4,985	80
1912...............	1,689	630	792	2,359	5,470	95
1913...............	1,685	689	807	2,392	5,573	95
1914...............	1,749	713	805	2,475	5,742	99
1915...............	1,968	728	815	2,194	5,705	87
1916...............	2,505	728	904	2,447	6,584	90
1917...............	3,665	784	1,127	4,714	10,290	139
1918...............	3,839	989	1,335	5,641	11,804	133
1919...............	4,077	1,089	1,515	5,576	12,257	112
1920...............	2,490	1,093	1,780	5,324	10,687	92
1921...............	1,874	950	1,159	1,832	5,815	52
1922...............	2,248	732	1,122	2,831	6,933	82
1923...............	2,588	685	1,219	3,266	7,758	88
1924...............	2,992	691	1,224	2,842	7,749	76
1925...............	2,817	672	1,243	4,230	8,962	111
1926...............	2,588	706	1,326	4,071	8,691	107
1927...............	2,900	710	1,280	3,542	8,432	95
1928...............	2,765	743	1,268	4,003	8,779	108
1929...............	2,648	794	1,284	4,096	8,822	112
1930...............	1,995	798	1,134	3,004	6,931	89
1931...............	1,227	629	847	2,242	4,945	83
1932...............	866	649	584	1,390	3,489	69
1933...............	1,225	394	512	2,010	4,141	111
1934...............	1,591	375	601	2,160	4,727	105
1935...............	1,855	388	740	3,228	6,211	139
1936...............	1,995	498	880	3,204	6,577	135
1937...............	1,924	493	1,039	3,871	7,327	141
1938...............	1,697	516	1,000	3,003	6,216	115
1939...............	1,854	513	982	3,148	6,497	121
1940...............	1,904	501	1,000	3,328	6,733	126
1941...............	2,580	513	1,197	4,835	9,125	151
1942...............	3,589	656	1,566	7,404	13,215	176
1943...............	4,105	860	1,928	9,185	16,078	165
1944...............	4,355	907	2,094	8,926	16,282	132
1945...............	4,303	935	2,210	9,562	17,010	130

[1] Data used in figure 16 derived from this table.

TABLE 54.—*Index numbers of net land returns and value per acre, and ratio of rent to land value, United States, 1912–45*

[1935–39 = 100]

Year	Land value per acre	Net land returns per acre	Ratio of returns to value	Year	Land value per acre	Net land returns per acre	Ratio of returns to value
			Percent				*Percent*
1912........	117	100	4.4	1930.......	138	110	5.6
1913........	121	100	4.5	1931.......	128	66	4.6
1914........	124	103	4.3	1932.......	107	46	3.3
1915........	124	115	4.5	1933.......	88	64	2.8
1916........	131	147	4.7	1934.......	92	80	3.7
1917........	142	215	5.6	1935.......	95	95	4.5
1918........	156	223	7.4	1936.......	99	105	5.2
1919........	169	232	7.1	1937.......	102	103	5.5
				1938.......	103	93	5.4
1920........	205	146	6.1	1939.......	101	104	4.9
1921........	190	113	4.2				
1922........	168	132	3.6	1940.......	102	107	5.5
1923........	163	153	4.4	1941.......	103	148	5.6
1924........	157	181	5.3	1942.......	110	209	7.2
1925........	153	165	6.3	1943.......	120	243	9.4
1926........	150	150	5.9	1944.......	138	264	9.5
1927........	144	164	5.6	1945.......	152	262	9.3
1928........	142	154	6.2				
1929........	140	143	5.9				

TABLE 55.—*Index numbers of production costs and real returns to farm labor, United States, 1910–45* [1][2]

[1935–39 = 100]

Year	Production costs per unit of farm output in 1935–39 average dollars	Real labor returns per unit of farm output	Real labor returns per farm worker	Farm output per farm worker
1910.	120	126	87	68
1911.	119	100	71	72
1912.	118	114	83	73
1913.	119	116	85	74
1914.	119	114	86	75
1915.	112	94	76	80
1916.	120	98	72	74
1917.	124	147	107	72
1918. . . . . .:. . .	118	137	111	81
1919.	120	115	97	83
1920.	116	102	90	88
1921.	131	67	52	77
1922.	118	83	70	85
1923.	116	91	78	87
1924.	114	83	72	87
1925.	111	105	93	89
1926.	111	102	92	90
1927.	111	93	85	92
1928.	108	97	93	96
1929.	111	102	96	94
1930.	114	84	79	93
1931.	103	67	69	102
1932.	103	52	53	100
9933.	108	73	67	92
1934.	120	84	67	80
1935.	101	97	92	94
1936.	114	114	96	84
1937.	93	103	112	108
1938.	96	91	97	106
1939.	96	95	103	108
1940.	94	96	108	112
1941.	92	118	141	120
1942.	85	134	179	134
1943.	80	154	203	132
1944.	88	140	196	140
1945.	89	144	206	143

[1] See footnote 11, page 73.
[2] Data used in figure 17 derived from this table.

TABLE 56.—*Real income per farm worker and per industrial worker, United States, 1910–45* [1] [2]

Year	Real income per farm worker	Real income per industrial worker	Real income per industrial worker adjusted for unemployment	Index numbers (1935–39=100)		
				Real income per farm worker	Real income per industrial worker	Real income per industrial worker adjusted for unemployment
	Dollars	*Dollars*	*Dollars*			
1910...	334	868	855	87	76	89
1911...	275	826	792	71	72	83
1912...	319	833	813	83	72	·85
1913...	328	845	823	85	74	86
1914...	333	838	791	86	73	83
1915...	292	864	813	76	75	85
1916...	276	890	886	72	77	93
1917...	413	889	889	107	77	93
1918...	427	994	994	111	87	104
1919...	373	958	958	97	83	100
1920...	347	987	974	90	86	102
1921...	200	964	856	52	84	90
1922...	272	985	918	70	86	96
1923...	303	1,044	1,026	78	91	107
1924...	277	1,043	995	72	91	104
1925...	359	1,034	1,015	93	90	106
1926...	355	1,046	1,036	92	91	108
1927...	330	1,057	1,020	85	92	107
1928...	359	1,076	1,034	93	94	108
1929...	369	1,093	1,060	96	95	111
1930...	304	1,050	956	79	91	100
1931...	266	1,037	871	69	90	91
1932...	203	948	720	53	83	75
1933...	260	978	734	67	85	77
1934...	257	1,024	799	67	89	84
1935...	356	1,080	864	92	94	90
1936...	370	1,141	958	96	99	100
1937...	433	1,183	1,017	112	103	106
1938...	375	1,123	921	97	98	97
1939...	396	1,217	1,022	103	106	107
1940...	417	1,273	1,095	108	111	115
1941...	544	1,424	1,310	141	124	137
1942...	690	1,593	1,593	179	139	167
1943...	785	1,755	1,755	203	153	184
1944...	757	1,859	1,859	196	162	194
1945...	797	1,758	1,758	206	153	184

[1] Yearly returns to labor per farm worker were deflated by the index of prices paid by farmers for commodities used in living (1935–39=100), and average annual wages per industrial worker were deflated by the B.L.S. Cost-of-living index (1935–39=100). Adjustment of industrial workers' income for unemployment was made by multiplying the percentage employed in labor force by the unadjusted income per worker.

[2] Data used in figure 18 derived from this table.